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SVIC NOTES

ACOUSTIC INTENSITY

Some of you in the shock and vibration community may already be aware of powerful new acoustic intensity measurement techniques, especially if in your job you have occasion to deal with acoustics. In this brief note, I will define acoustic intensity, how it is measured, discuss some of its pros and cons and show a few samples of its applications to noise and vibration reduction problems.

Acoustic intensity is a vector measure of the acoustical energy flow per unit area of a sound wave. This is in contrast to sound pressure which is a scalar quality. In an acoustic medium without mean flow, the intensity vector $\vec{I}$ equals the time averaged product of the instantaneous pressure $p(t)$ and the corresponding particle velocity $\vec{u}(t)$ at the same position.

$$\vec{I} = \langle p(t) \cdot \vec{u}(t) \rangle \tag{1}$$

(where $\langle\ \rangle$ indicates time averaging).

In order to measure the acoustic intensity, the instantaneous pressure and the corresponding particle velocity must be known. The pressure can be easily measured directly. However, a direct measurement of particle velocity is very difficult, requiring the use of devices like hot wire anemometers, or delicately suspended mica discs. A different, indirect method using two identical closely spaced pressure microphones is preferable. The method consists of making an approximation to the pressure gradient by measuring the pressures p_A and p_B at two closely spaced points A and B and dividing by the transducer separation Δr.

$$\text{PRESSURE GRADIENT} \approx \frac{p_B - p_A}{\Delta r} \tag{2}$$

Since the pressure gradient is proportional to the particle acceleration, the particle velocity can then be obtained by integrating the pressure gradient with respect to time.

A practical sound intensity probe can therefore consist of two closely spaced pressure microphones, allowing for measurement of both pressure and the component of the pressure gradient along a line joining the centers of the microphones. Using an equation similar to equation (1), the acoustic intensity vector component along the line joining the two microphones can then be calculated.

The advantages of this technique for noise source identification are many. It is quicker than conventional lead wrapping techniques, and it is a noncontact technique. Mounting accelerometers is time consuming and can change acoustic emissions. You can make some acoustic intensity measurements without an anechoic or reverberant chamber. This is probably its biggest asset.

The disadvantages are the limitations imposed by microphones such as requirements for calibration and how to deal with phase errors. Also, the hardware and software is still complex and costly.

The most important applications so far have been in noise source identification. Three applications of the technique have been noise source identification in diesel engines, measurement of transient noise sources and the measurement of transmission loss of panels.

One major application is in the computer aided design of structures where modal analysis and acoustic intensity measurements can be linked. Using modal analysis, the radiation efficiencies of individual modes can be predicted. Changes in the acoustic radiation due to slight structural modifications can then be calculated. Making actual acoustic intensity measurements then allows for a comparison between theory and experiment.

In summary, acoustic intensity is a powerful, new measurement technique which has been applied quite successfully to noise reduction problems but will, in the future, find many more applications throughout the shock and vibration community, especially in the areas where modal analysis, modal testing and acoustics overlap.

J.G.S.

EDITORS RATTLE SPACE

DEVELOPING THE USEFULNESS OF TEST EQUIPMENT

Microprocessors have been used to good advantage by the developers of data storage, management techniques, and processing equipment. In fact, engineers and technicians often do not use the full capability of equipment. Features on some instrumentation often go unused because testing techniques are not available or the features are not needed. It would seem, therefore, that more research is needed into data processing equipment and methods for using it.

Test equipment and instrumentation are being developed at a fantastic pace. New equipment appears on the market almost daily. Indeed, the variety of equipment now available often confuses the purchaser who is relatively new to the field. Sometimes it seems that a feature is incorporated into new instrumentation because vendors think it is needed rather than because the user needs it. The reason is lack of in-depth research before the planning and design stages. It would be useful for equipment vendors to talk to more users about their needs and requirements. Perhaps less emphasis would be placed on "bells and whistles" and more on substantial data processing capabilities for users.

The development and formalization of testing techniques and procedures would facilitate more complete use of the features of data processing equipment. Vendors that have developed new and useful techniques to process and evaluate data based on their equipment have done well. It is reasonable to conclude that more research would benefit both the vendors and the users. Such research could be done in universities if they had the test equipment and facilities. Perhaps it would benefit all parties if the developers of instrumentation provided equipment for this type of research.

The advent of new test equipment has increased the capabilities of engineers and technicians. New techniques have been developed as a result of new capabilities in hardware. However, increased capability is often accomplished by brute force -- massive data processing -- rather than by gaining physical insight into the machine or device being tested. Unless there are new developments in the use of test equipment that will increase the productivity of the user, continued sales of improved data processing equipment will not be sustained. Managers are motivated by profits, not by "bells and whistles."

R.L.E.

Announcement and Call for Papers

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IMPEDANCE METHODS FOR MACHINE ANALYSIS: MODAL PARAMETERS EXTRACTION TECHNIQUES

M. Massoud*

Abstract. Earlier papers reviewed basic definitions, mathematical background, and a broad spectrum of industrial applications of impedance methods. These methods are based on the analysis of frequency response measurements between relevant points on machine structures. The advent of practical and affordable microprocessor-based systems has given rise to algorithms for the precise extraction of modal parameters from frequency response measurements and the subsequent estimation of physical parameters of machine structures. This paper reviews recent advances in the algorithms.

For purposes of dynamic analysis machine structures are traditionally modeled as lumped parameter n-degrees-of-freedom systems. The motion of n significant points on a structure is thus described by a linear second order matrix differential equation that exhibits reciprocity between force and response at any two arbitrary points. This relation between force and response requires experimental measurements and analysis procedures that are known collectively as impedance methods. The measurements are usually obtained by FFT-based two-channel digital spectrum analyzers that display frequency response functions (FRF) in the form of mechanical impedance D (ω) (force/response) or mobility H (ω) (response/force) [1]. The graphical display of the FRF allows the engineer to gain an understanding of the behavior of a structure during external excitations.

These measurements, however, can be used as input to software used to process modal parameters in order to identify the modal parameters of structures; such parameters can be used to verify or synthesize a mathematical model of a structure. Processing software is often based on analytical curve-fitting procedures; they adjust unknown parameters in a mathematical model to minimize errors between analytical and experimental results. The software then synthesizes an analytical FRF superposed on the graphical display of the experimental FRF. During the last decade these techniques have emerged from the research laboratory and become part of the practitioner's repertoire.

These techniques have been used to analyze time and frequency domain results, but this paper reviews only bases of algorithms used in conjunction with frequency domain analysis. The presentation covers the algorithms needed to extract modal parameter estimates (mode shapes, natural frequencies, and damping parameters). The article does not cover details of the experimental procedures. References to the latter are available [3-5]. Nor does the article include descriptions of the process of obtaining physical parameter estimates (inertial and stiffness parameters) from modal parameters.

FREQUENCY RESPONSE FUNCTION (FRF)

Analytical background. The FRF representation [6] begins with a second order matrix differential equation of an n-degrees-of-freedom system

$$\big[[M]\ \{\ddot{X}\} + [C]\ \{\dot{X}\} + [K]\big]\{X\} = \{f\} \quad (1)$$

The Laplace transform of equation (1) with zero initial conditions is

$$\begin{aligned}\big[[M]\ S^2 + [C]\ S + [K]\big]\ \{X(S)\} &= \{F(S)\}\\ [D(S)]\ \{X(S)\} &= \{F(S)\} \quad (2)\end{aligned}$$

[D(S)] is the impedance matrix of the system. Each element of this matrix is an impedance function d_{iq}.

Equation (2) can also be written as

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$$\{X(S)\} = [H(S)]\,\{F(S)\} \tag{3}$$

and

$$[H(S)] = [D(S)]^{-1} \tag{4}$$

[H(S)] is the transfer matrix of the system. Each element of this matrix is a transfer function h_{iq} describing the response at point (i) to a force at point (g).

The relation in equation (4) can also be written as

$$[H(S)] = [D(S)]^{-1} = \frac{\text{Adjoint matrix of } [D]}{\text{Determinant of } [D]} \tag{5}$$

Because both the adjoint matrix of [D] and the determinant of [D] are polynomials in S, the elements of [H] are a rational fraction in (S) [6-8] given by

$$h_{ig}(S) = \frac{X_i(S)}{F_g(S)} = \frac{a_0 S^n + a_1 S^{n-1} + \ldots + a_n}{\ell_0 S^{2n} + \ell_1 S^{2n-1} + \ldots + \ell_{2n}} \tag{6}$$

The poles of the system are given by the roots p_r of the determinant of [D]. If it is assumed that the poles are of unit multiplicity and that the system is inherently underdamped, the rational fraction form shown in equation (6) can also be represented by the following partial fraction form

$$h_{ig}(S) = \sum_{r=1}^{n} \frac{a_{ig}^{r}}{S - p_r} + \frac{a_{ig}^{r\,*}}{S - p_r^*} \tag{7}$$

where $*$ = complex conjugate

a_{ig}^{r} = residue element = $u_{ir}\, u_{gr} = \bar{\bar{a}}_{ig} - j\, \bar{a}_{ig}$

u_{ir} = eigen vectors of the matrix [D]; each element of this vector is u_{ir}, r = 1, . . . n

$p_r = -\sigma_r + j\omega_r$ = eigen values of the matrix [D]

σ_r = damping factor

ω_r = damped natural frequency

In a test situation, a transfer matrix [H(S)] is limited to values of S having a zero real part. This case results in the frequency response matrix $[H(j\omega)]$. Each element of this matrix is an FRF $h_{ig}(\omega)$ where

$$h_{ig}(\omega) = \sum_{r=1}^{n} \frac{a_r(\omega)}{j\omega - p_r} + \frac{a_r^*(\omega)}{j\omega - p_r^*} \tag{8}$$

The resonance curve representing $h(\omega)$ is thus generated by summing two terms. One term describes the motion primarily around the positive pole; the other one describes the motion primarily around the negative pole. Typically the FRF is measured only for positive frequencies; the first term of equation (8) can then describe the required FRF

$$h_{ig}(\omega) = \sum_{r=1}^{n} \frac{a_r(\omega)}{j\omega - p_r} = \sum_{r=1}^{n} \frac{(\phi_{ir}\, \phi_{gr})}{j\omega - p_r} \tag{9}$$

where ϕ_r is the r^{th} complex mode of motion.

The FRF is a general definition that assumes different names [1] according to the intended response; thus,

$$\frac{x_i}{F_g} = \text{receptance or compliance}$$

$$\frac{\dot{x}_i}{F_g} = \text{mobility} \tag{10}$$

$$\frac{\ddot{x}_i}{F_g} = \text{inertance}$$

The analysis and parameter extraction processes are performed using any of these frequency functions; they are experimentally measured and graphically displayed.

Graphical representation. The graphic display of FRF results allows the engineer to understand structural dynamics. The FRF measured in a test situation is often the element $h_{ig}(\omega)$ -- equation (9) -- and is obtained from an exciter at location (g) and response location (i). Some of the alternative forms in which this function is commonly plotted are available [9-11]:

- Bode plot, a log-magnitude and phase vs frequency
- Nyquist plot, the real part of the FRF against the imaginary part; the frequency is not shown explicitly but appears as a parameter along the curve

- CO-QUAD, the real (COincident) and imaginary (QUADrature) parts of the function vs frequency

- Nichols plot, log-magnitude vs phase angle

The first three formats are used extensively for modal analysis algorithms and curve fitting procedures. The Nichols plot has been extensively used to analyze servo-mechanisms. Another graphic format, which plots the transfer function h_{ig} (S) over the S-plane, shows the locations of the poles ($\sigma \pm j\,\omega$); however, its use in parameter estimation is limited.

A careful examination of the graphical forms of the frequency functions presented by any of the above formats reveals the nature of the vibration modes of the structure. The process of identifying parameters from these graphic representations, commonly called curve fitting or parameter estimation, is used to identify natural frequencies, damping, and mode shapes.

Most FFT machines today compute an estimate of the FRF by cross-spectral density methods that are based on the following equations (12)

$$h_{ig}(\omega) = \frac{G_{x_i\ f_g}}{G_{x_i\ x_i}} \qquad (11)$$

or

$$h_{ig}(\omega) = \frac{G_{f_g\ f_g}}{G_{x_i\ f_g}} \qquad (12)$$

$G_{x_i\ x_i}$ and $G_{f_g\ f_g}$ are the power spectral densities of the response at location (i) and the force at location (g); $G_{x_i\ f_g}$ is the cross-spectral density. Mitchell and Elliot [13, 14] recently reported poor coherence of data obtained from equation (11) close to anti-resonance and those obtained from equation (12) close to resonance. The authors attribute the poor coherence to contamination by noise at the input and output at the indicated positions. They suggested alternate methods for computation of the FRF based on a strategy of combining expressions (11) and (12). The coherence expression is used to switch from one expression to the other whenver its value falls below a limiting value. This strategy results in improved plots of the FRF in the Bode or Nyquist formats. The use of multi-group averaging technique has been suggested to obtain a smooth representation of the FRF to eliminate the influence of some noise factors [15].

MODAL DENSITY AND CURVE FITTING ALGORITHMS

Modal extraction algorithms differ according to the nature of the FRF graphical data being analyzed. An FRF is characterized by its modal density, which is a loose judgment concerning the frequency proximity of adjacent modes. A structure exhibiting low modal density has resonances widely spaced in frequency and light damping (see Figure 1). None of the modes appears to overlap or couple. A structure exhibiting high modal density demonstrates proximity of adjacent modes or heavy damping (Figure 2). The following index has been proposed [16] to describe the modal density quality of a structure:

$$\text{average modal density} = \frac{\text{average modal bandwidth}}{\text{averaged natural frequency spacing}}$$

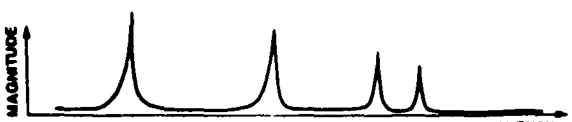

Figure 1. Frequency Response Function of a Structure with Low Modal Density; Light Modal Overlap

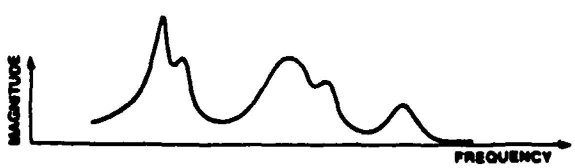

Figure 2. Frequency Response Function of a Structure with High Modal Density; Heavy Modal Overlap

Curve fitting algorithms used for the analysis of low modal density structures are collectively based on SDOF (single-degree-of-freedom) procedures. The latter are basically peak-picking procedures. High modal density structures require MDOF (multi-degree-of-freedom) procedures; they are basically recursive algorithms that look at the entire FRF curve at one time. The three main requirements for a good curve fitting algorithm in a measured system are: execution speed, numerical stability, and ease of use. The precision of the final data, however, depends on considerations related to the total number of the FRF measurements required. This is outside the scope of this presentation; but a few remarks will be helpful for subsequent discussion of the different algorithms. The data required are based on one of the following methods:

- One at a time method. This requires one row or one column data of the frequency response matrix. One row data are obtained by a single exciter at one location and a roving response transducer reading at all locations, one at a time. One column data requires a response transducer at one location and roving exciter locations. More than one row and one column data might be advisable to obtain better estimates of modal parameters.

- Multiple input and response methods. More sophisticated measurements involving multiple inputs and responses obtained simultaneously are implemented.

SINGLE-DEGREE-OF-FREEDOM METHODS (SDOF)

Single mode analysis relies on the assumption that, in the region of the natural frequency, each mode dominates the response plot. This assumption is valid for low modal density structures, the analysis based primarily on the phase resonance technique pioneered by Kennedy and Pancu [9].

Basically the mode parameters are derived from the Bode plot by peak-picking procedures or from the angular spacing of frequency data around modal circles in the Nyquist plot, details are available [10, 11].

Limited information can be obtained from a Bode plot. If damping is viscous, the frequencies at which the peak occurs at resonance indicates: $\Omega_r \sqrt{1 - 2\zeta_r^2}$ for compliance plot, Ω_r for mobility plot, and $\Omega_r\ (1 - 2\zeta_r^2)^{-1/2}$ for inertance. The symbol Ω_r is the undamped natural frequency; ζ_r is the corresponding damping ratio. Estimates of the latter can be obtained from the half power point [9]. Mode shapes are not easy to obtain; however, the use of quadrature response values of inertance or compliance to estimate mode shapes at each resonance frequency has been suggested [17]. To overcome the difficulty of mode shape estimation, multi-input sine dwell [3] can be used to excite a pure mode; measurements can be obtained by roving transducers.

Information from CO-QUAD plots is derived from equations (7) and (9) written in the following form in the neighborhood of the r^{th} mode

$$h_{ig}(\omega) = \frac{a^r_{ig}}{(j\omega - p_r)} \quad \text{(complex expression)}$$

$$\mathrm{Re}\,[h_{ig}(\omega)] = \frac{\bar{a}_{ig}\,(\omega_r - \omega) + \bar{\bar{a}}_{ig}\,\sigma_r}{(\omega_r - \omega)^2 + \sigma_k^{\,2}} \tag{13}$$

$$\mathrm{Im}\,[h_{ig}(\omega)] = \frac{\bar{\bar{a}}_{ig}(\omega_r - \omega) - \bar{a}_{ig}\,\sigma_r}{(\omega_r - \omega)^2 + \sigma_k^{\,2}}$$

At modal resonance equations (13) become,

$$R_e\,[h_{ig}(\omega_r)] = \frac{\bar{\bar{a}}_{ig}}{2\sigma_r}\ ,\quad \mathrm{Im}\,[h_{ig}(\omega_r)] = -\frac{\bar{a}_{ig}}{2\sigma_r} \tag{14}$$

Equations (14) and the CO-QUAD plots are used to evaluate complex mode shapes and natural frequencies and damping factors.

Rational fraction least squares fitted to the Bode plot in the vicinity of each resonance peak has been proposed [23] to identify one resonance at a time. Equation (6) will take the following form

$$h_{ig}(\omega) = \left.\frac{\bar{\bar{a}}_{ig}\,S + \bar{\bar{a}}_{ig}\,\sigma_r + \bar{a}_{ig}\,\omega_r}{S^2 + 2\sigma_r\,S + \sigma_r^{\,2} + \omega_r^{\,2}}\right|_{S\,=\,j\omega} \tag{15}$$

Equation (15) is fit in a least squared error sense to the measurement data. The modal parameters are

obtained by determining the unknown parameters of equation (15).

Another SDOF method uses the Nyquist plot for parameter estimation. A typical Nyquist plot of a multi-degree-of-freedom system is shown in Figure 4; that of a single degree of freedom is shown in Figure 3. The latter is a perfect circle for structural damping. If damping is viscous, the mobility plot yields a perfect circle [20]. If these circles pass through the origin, the Nyquist plot of the inverse FRF given by $d_{ig}(a)$ -- equation (2) -- is a straight line [19, 20]. These facts are used to fit mathematical circles on the measured FRF or mathematical straight lines on the inverse FRF. The theoretical background of circle fitting procedures has been described [18, 21]. The diameter of the circle determines the relative movement of the response coordinate being calculated. The natural frequency is determined by the maximum rate of change of arc length with frequency. Modal mass, modal stiffness, and modal damping can also be estimated. The curve fitting algorithm is based on least square errors of the coordinates of a number of points in the vicinity of the natural frequency [18]. A weighted least squares method based on the straight line representation of the inverse FRF has been described [20]. Circle fit procedures are used to prove the superiority of the FRF data obtained by a recommended strategy [13, 14].

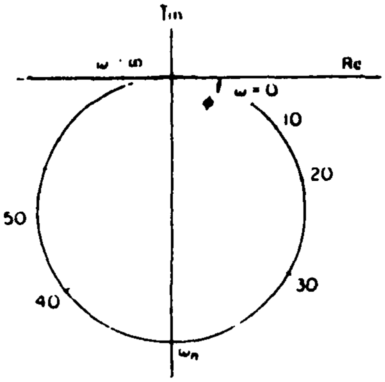

Figure 3. Nyquist Plot of a Single-Degree-of-Freedom System

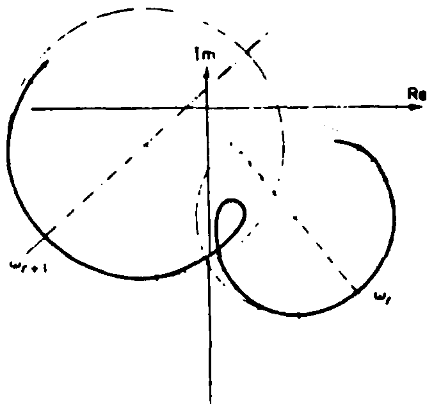

Figure 4. Nyquist Plot of a Multi-Degree-of-Freedom System

MULTI-DEGREE OF FREEDOM METHODS (MDOF)

When modal density is high and modal overlap is heavy, SDOF approaches can yield parameter estimates with large errors. This situation also occurs in symmetric structures; they often show multiple unique modes at essentially the same frequency. In such cases the parameters of all modes must be identified simultaneously using MDOF methods. This section is limited to methods based on frequency domain analysis.

Procedures based on an extension of SDOF methods. Earlier procedures are based on the use of multiple sets of one point excitation FRF data given in multi-rows or multi-columns of the response matrix. These procedures [10] use iteration techniques among the data to improve parameter estimates. Real modes and proportional damping are frequently assumed. Other procedures [19] are based on fitting circles on Nyquist plots. These plots comprise a series of loops (Figure 4). Coupling of modes causes mutual distortion of the loops. In cases of high modal density two loops sometimes degenerate to give a smooth transition between arcs. The method is based on fitting circles on the arcs, each of which represents a mode shape. The procedures are repeated on all sets of data. The center of each fitted circle is translated from the theoretical position and the circle itself rotates. The magnitude of translations and rotations and the relative sizes of the fitted circles can be interpreted

in terms of complex mode shapes, frequency, and damping information.

The introduction of complex mode shapes and complex frequency parameters allows the use of more advanced methods based on global curve fitting procedures on single or multiple FRF data sets. Some of these methods are reviewed below.

Curve fitting using rational fractions. The use of rational fractions to fit a methematical expression around one natural frequency plot -- equation (15) -- is mentioned as a SDOF method. The method has now been extended to fit curves over several modes. Each FRF record is processed to obtain an expression of a ratio of two polynomials, equation (6). The difference between the absolute magnitude of the actual function on a Bode plot and the polynomial ratio is the error considered. The polynomial coefficients are evaluated by minimizing the errors in a least square sense. Algorithms of these procedures have been described [7, 22, 23]. The greatest difficulty with curve fitting polynomials is that the solution equations are ill-conditioned; they thus are difficult to solve on minicomputers. Some of the problems and sources of errors associated with these algorithms have been reported [23, 24].

Curve fitting using orthogonal functions. Various types of orthogonal polynomials can be used to express the FRF in a finite series composed of a set of approximating function $\phi_p(\omega)$ [22] as follows

$$h_{ip}(\omega) = \sum_{p=1}^{m} K_m \phi_m(\omega) \tag{16}$$

The functions $\phi_m(\omega)$ satisfy the following orthogonality conditions.

$$\int_a^b \phi_p(\omega) \quad \phi_r(\omega) \text{ P d } \omega = \delta_{(p,r)} W_p \tag{17}$$

P is the weighting function, and δ_{pr} is the kroneker delta. Several Jacobi, Legendre, Chebychev, Laquerre, and Hermite polynomials have been described for the function ϕ [22, 25].

Another method combines features of the rational fractions and the orthogonal functions [23]. This method removes much of the ill-conditioning associated with the use of the rational fraction method; at the same time it reduces the number of equations to be solved to about half of those required for the rational fraction representation. The reduction takes advantage of a special property of the FRF as well as the orthogonality properties, equation (17), of the polynomials to greatly simplify the calculations. The following expression is suggested

$$h_{ig}(\omega_p) = \frac{\sum_{k=0}^{m} c_k \, \phi_{(p,k)}}{\sum_{k=0}^{n} d_k \, \theta_{(p,k)}} \tag{18}$$

The two functions ϕ and θ satisfy orthogonality conditions similar to equation (17), as follows

$$\sum [\phi_{(p,k)}]^* [\phi_{(p,j)}] = 0.5 \, \delta_{(k,j)} \quad ($$

$$\sum [\theta_{p,k}]^* |h_{ig}|^2 [\theta_{p,k}] = 0.5 \, \delta_{(k,j)}$$

The weighting function for θ is the square of the amplitude of the FRF. The polynomial coefficients are evaluated by the same procedures used for the rational fraction approach. The orthogonal functions needed are generated by the Forsythe method [23, 25].

Complex exponential Prony method. This MDOF estimation technique looks simultaneously to all modes of a single input measurement. The basis of this method was formulated by Prony [27] in the eighteenth century, yet its implementation is new. The method is based on fitting a complex exponential function to the time impulse response function instead of the frequency response function FRF. The latter can be synthesized, however, by taking the Fourier transform of the time impulse response. In like manner, if the FRF is available, an inverse Fourier transform can be used to synthesize an impulse response. The relations between the two responses are given by the following expressions:

Let $x_i(t)$ be the impulse response at point (i) due to an initial condition at point g

$$x_{ig}(t) = \sum_{r=1}^{n} a_{ig}^{r} e^{p_r t} - a_{ig}^{r} e^{p_r^* t} \quad (20)$$

(complex exponential function)

$$= \frac{1}{2} \sum_{r=1}^{n} |a_{ig}^{r}| e^{-\sigma_r t} \sin(\omega_r t + \alpha_{ig}^{r}) \quad (21)$$

(damped sinusoidal function)

where a_{ig}^{r}, p_r, σ_r, and ω_r are as given in equation (7); α_{ig}^{r} is the angle of the residue. Equation (20) is the inverse Laplace transform of equation (7); its inverse Fourier transform is given by equation (9).

The MDOF exponential approach is basically a time domain manipulation of time samples of free sinusoidal decay experimental results; the results are introduced in equations (20) and (21) to obtain estimates of residue and pole values (a_{ir} and p_r). The modal parameter values are then obtained by standard algorithms. The FRF can be estimated, synthesized, and displayed for comparison with FRF experimental results using an inverse Fourier transformation.

Another frequency domain version of the exponential approach [28] is based on a more general expression of the free transient response of a single input measurement given by

$$x_{ig}(t) = \sum_{r=1}^{n} C_{ig} e^{p_r t} H(t) + C_{ig}^{r*} e^{p_r^* t} H(f) \quad (22)$$

H(t) is the heavyside step function. The Fourier transform of equation (22) expresses the frequency response as

$$x_{ig}(\omega) = \sum_{r=1}^{n} \frac{C_{ig}^{r}}{j\omega - p_r} + \frac{C_{ig}^{r*}}{-j\omega - p_r^*} \quad (23)$$

The algorithm defines a series of shifted responses $x_{in}(t)$, performs the inverse transform of each using equation (23), then samples the frequence responses at 2n frequencies. The results are compiled in a matrix form

$$[X] = [C]\ [P] \quad (24)$$

The process is repeated for twice-shifted samples, and an equation similar to equation (24) is constructed. The results are manipulated to extract the modal parameters.

The poly-reference method. The poly-reference method, a recent implementation of the complex exponential approach [32, 33, 35], includes information from multiple initial conditions at multipoint locations simultaneously. The method is oriented to minicomputer systems and is basically time-domain oriented; its application in frequency domain is possible using Fourier transformations.

The mathematical derivations [29-31] are based on a set of equations similar to equation (20), in which the sub-index g refers to multi-initial conditions applied simultaneously. For a specific measuring point i and different initial conditions g, equation (20) can be written in the following matrix form

$$\{X_{ig}(t)\} = [W]\ [\ e^{p_r t}\ ]\ \{a_{ig}^{r}\} \quad (25)$$

[W] is a weighting matrix that is unity for impulses. Equation (25) is estimated for several time increments Δt. Each increment has an equation derived from equation (25); an over-determined set of equations should be solved. These equations can be expressed in a matrix form with a rectangular coefficient matrix. A pseudo-inverse procedure is used to obtain the inverse of the coefficient matrix. The procedure is used to obtain the inverse of the coefficient parameters p_r and a_{ig}^{r}. The results are used to extract the modal parameters.

GLOBAL FITTING

Based on the complex mode formulation of the FRF in equation (7) other global curve fitting algorithms can be proposed. These algorithms aim at reducing errors between the mathematical model of equation (7) and experimental results. Most of these algorithms are based on optimization approaches with the error as objective functions and constraint equations to be satisfied. The optimization model uses information from the response matrix. Details of these procedures are available [36-38]. The question of fitting curves to physical experimental data has been discussed [39].

CONCLUSION

This paper is a survey of basic procedures now used to obtain modal parameter estimates from frequency response experimental data. Most of the SDOF and MDOF procedures are commercially available. All of these methods are based on commonly used FRF measurement procedures, in which the linearity between response and force is strictly assumed. However, it is frequently the case that an actual structure, even though it is a simple one, cannot satisfy linearity [40, 41]. Improvement in structure parameter estimates can be introduced when nonlinear models are used.

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LITERATURE REVIEW: survey and analysis of the Shock and Vibration literature

The monthly Literature Review, a subjective critique and summary of the literature, consists of two to four review articles each month, 3,000 to 4,000 words in length. The purpose of this section is to present a "digest" of literature over a period of three years. Planned by the Technical Editor, this section provides the DIGEST reader with up-to-date insights into current technology in more than 150 topic areas. Review articles include technical information from articles, reports, and unpublished proceedings. Each article also contains a minor tutorial of the technical area under discussion, a survey and evaluation of the new literature, and recommendations. Review articles are written by experts in the shock and vibration field.

This issue of the DIGEST contains an article about vibration control with viscoelastic materials.

Professor B.C. Nakra of Indian Institute of Technology, New Delhi, India has written a review of work on the analysis of layered structures in which layers of viscoelastic materials are used for damping, work on the use of discrete dampers, work on properties of viscoelastic materials, and engineering applications of techniques employing viscoelsatic materials for vibration damping.

VIBRATION CONTROL WITH VISCOELASTIC MATERIALS - III

B.C. Nakra*

Abstract. This paper reviews work on the analysis of layered structures in which layers of viscoelastic materials are used for damping, work on the use of discrete dampers, work on properties of viscoelastic materials, and engineering applications of techniques employing viscoelastic materials for vibration damping.

ANALYSIS OF LAYERED STRUCTURES

In earlier papers [42, 43] references were reviewed that dealt with vibration analyses of beams, plates, and shells in which layers of viscoelastic materials were used in constrained or unconstrained arrangements. Additional references are also available [1, 2, 30, 37-39, 59]. Mead [40] compared in detail the equations reported for the flexural vibrations of sandwich beams with viscoelastic cores; he also discussed the application of various available equations. An alternative method of formulation based on the integral equation approach has been reported [23]. An analysis for sandwich beams with viscoelastic core and outer layers of box section has been reported [11], as have analyses for thin-walled open section beams with unconstrained [45] and constrained [46] damping treatments. The governing equations and results for curved sandwich beams with viscoelastic cores are available [70, 74], as are those for singly and doubly curved sandwich panels [74].

Earlier work on the shock response of viscoelastically damped sandwich beams has been reviewed [42, 43] and extended to plates [14]. Response and damping analyses for unconstrained layer damping treatment subjected to random acoustic excitation have been published [61], as have analyses for constrained viscoelastic beams to random excitation [27, 28]. Analyses of damped complex structures comprising a system of viscoelastically damped beams and isolators have been reported [64, 75-77].

Results of experimental verification have been published [19] for a theoretical formulation for large deformations of three-layered beams with viscoelastic cores. The analysis of framed structures with constrained damping treatment has been reported [13].

There has been considerable interest in the application of the finite element method (FEM) to layered damped structures. The FEM has been applied to panels with a number of layers, including viscoelastic layers for damping and stiffeners on the panel surface and tuned discrete dampers [5]. The FEM for laminated structures incorporating viscoelastic layers has also been used by others [8, 18, 21, 22, 24, 31, 32, 67, 72].

Ozguven [53-55] analyzed damped layered plates by reducing the arrangement to a single layer plate with complex equivalent modulus. He later introduced lumped parameters and used finite elements; he reduced the complex modulus plate to one with real modulus and a set of discrete dampers between certain plate nodes and the ground.

The effect of nonuniform distribution of unconstrained damping treatment has been considered; a tapered viscoelastic layer on a cantilever beam with increased thickness at the clamped edge has been analyzed [60]. Optimization of the distribution of additive damping treatment on beam and frames has been carried out with analyses using nonuniform damping for cost reduction [34-36]. Optimum design studies of sandwich plates with viscoelastic core have been reported [29].

Transmission of sound through damped sandwich panels has been analyzed [10, 12, 15], as has sound transmission through damped sandwich panels backed by an enclosure [47, 48].

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STRUCTURES WITH DISCRETE DAMPERS

Analyses of complex vibrating systems with discrete dampers or damping inserts have been reported [16, 78]. A procedure for designing a vibration absorber for attachment to a complex vibrating system has been reported [69]; the absorber has a polymer with damping. Analysis and results for damping and frequencies have been given for rectangular plates with intermediate viscoelastic line supports [65], and a vibration response analysis has been reported for vibration of beams with viscoelastic supports [44]. Applications of structures and mechanical systems incorporating discrete viscoelastic dampers have been described [49].

MATERIALS AND PROPERTIES

Viscoelastic materials commonly available and used for vibration damping applications have been described [4, 6, 26, 52]. Techniques for measuring properties and terminology used to describe the properties have been published [57]. The effects of such parameters as frequency, strain, and temperature on the dynamic properties of viscoelastic materials have been studied [9, 66]. It has been found that the effect of strain on dynamic properties -- an effect that is ignored in linear analysis -- is significant for such materials as polybutadiene. A method has been described [25] for measuring damping properties of thin viscoelastic layers as used in damping tapes. The method involves measuring the response of a beam with several layers attached and comparing the results with those tests of a beam with known material properties. An analysis of errors in finding properties of viscoelastic materials by the coated beam method has been published [58].

APPLICATIONS

A number of applications were reviewed earlier [42, 43]. Some additional ones are given in this section. A number of investigations for aerospace applications were reported at a recent conference [62]. These investigations [62] include additive damping treatment for jet engine inlet guide vanes [56, 63], airframes [3], antennas and aircraft dispensers [7], structure for aircraft optical systems [33], stringers and airplane frames [68], and aircraft structures such as antennas [71]. A number of possible applications of additive damping in aerospace systems have been listed [17, 41]. They include applications to instrument panels, inlet and tail pipes, and radar mounts. Investigations in aerospace systems appear to be aimed at reduction of possible fatigue in structures and noise control in cabins.

Investigations for application of viscoelastic damping methods to bearing supports for high speed rotors have been reported [66]. Applications in other fields include building structures [13, 20, 50], ship structures [51], and machine tool structural elements [73].

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BOOK REVIEWS

RANDOM FATIGUE LIFE PREDICTION

Y.S. Shin and M.K. Au-Yang, editors
ASME, New York, NY
1983, 149 pages

Severe service loading conditions require appraisals of fatigue damage in the design of mechanical systems and components. Fatigue is governed by a number of parameters, including mean stress, temperature, loading rate, stress concentrations, loading sequences, prestrain, random stress/strain, and corrosion effects. Because a precise mathematical expression for assessing fatigue damage is not available, it must be measured. Fatigue damage is constantly being researched under specific environments and conditions. This volume contains eleven papers.

The initial paper describes the strain range conversion principle for treating cumulative fatigue damage in the creep range. The author's interaction damage rule really expresses the way in which a set of hysteresis loops involving only single generic strains can combine to produce the same micromechanistic damage as the loop. The concept of strain range partitioning can be effectively used to synthesize independent loops and determine both healing and damaging effects.

In the second paper laboratory simulation of the low cycle behavior of the hook region of a turbine blade subjected to start/stop cycles is used. Such cycles result in significant cyclic plastic strain. Measured fatigue lives exceed the useful life of the turbine. High frequency vibratory stress appear to be a dominant cause of fatigue fractures.

The third paper is a report of the effect of variable amplitude histories on fatigue life under strain controlled conditions. Rainflow counting algorithms are used to examine the methods of damage summation. Based on experiments, plastic work interaction and J integral crack growth approach provide improved fatigue life estimates.

The fourth paper treats criteria for determining fatigue-design equivalent three-parameter log-normal distributions provided the three-parameter Weibull distribution parameters are known. However, the original test data of fatigue damage are not available. The author compares both distributions in terms of the cumulative probabilities of failure. The class of distributions with nonzero least lives requires special treatment in damage theories.

The fifth paper discusses probability-based high-cycle fatigue-life predictions. The cumulative fatigue damage index is represented as a random variable. The probability of fatigue failure is delineated such that the calculated fatigue damage index exceeds the critical fatigue damage index. Based on 37 sets of data, the Weibull distribution has the best fit; results are compared with those of log-normal distributions for a given power spectral density curve.

The next paper focuses on fatigue damage under variable amplitude cycling. A recently proposed mean stress parameter by the author is used to introduce a nonlinear damage accumulative process. The process is considered to replace usual linear procedures. Results of critical experiments to assess the suitability of the postulate are shown to support the nonlinear criteria. The reviewer feels that additional experimental evaluation on other materials is required.

The seventh paper reviews modern approaches to fatigue reliability and design. The author employs the Monte Carlo method, log-normal format, Weibull's format, and the Rackwitz-Fiessler algorithm. His calculations indicate that no general reliability method can be recommended.

The next paper surveys the state of the art of frequency effects in fatigue life. The author reviews existing data and emphasizes low frequency fatigue at room temperature in a non-corrosive environment. He states that frequency effects play an important role in material damping and becomes more significant at high frequencies and high strain amplitudes.

The ninth paper states that simple closed-form analytical expressions have been found to accurately predict the fatigue life of structures subjected to random stresses. The equations are applied to both high and low cycle fatigue and include elastic fracture mechanics. The expressions predict average and minimum cycles to failure plus probability of failure. Further study and experimentation are needed to establish the validity of the information presented.

The last paper considers the probabilistic analysis of piping systems. The deterministic analysis of the fatigue crack-growth process employs the worst case assumptions about initial size and coupling of pipe stresses due to steady-state plant operation. Based on previous calculations, the deterministic analysis greatly underestimates power plant life and is conservative. However, further work is required on environmentally assisted crack growth, crack initiation, common causes, and common mode model development.

These papers attempt to solve some of the mysteries of fatigue, but more theoretical and experimental work is necessary.

H. Saunders
1 Arcadian Drive
Scotia, NY 12302

THE FINITE ELEMENT METHOD IN ENGINEERING

S.S. Rao
Pergamon Press, Elmsford, NY
1982, 625 pages

The finite element method (FEM) was first applied to structures; it has been extended to heat transfer, fluid flow, and electromagnetic theory. This book covers in detail structural analysis (statics and dynamics), heat transfer, and fluid flow.

The author begins with a description of FEM and compares it with other methods of analysis; e.g., analytical solutions of vibration of a beam, Rayleigh's method, Galerkin's method, and finite difference equations. Chapter 2 presents solutions of finite element equations. They include Gauss elimination, Choleski and Jacobian methods, and the Rayleigh-Ritz subspace iteration method. The chapter concludes with direct integration and mode superposition methods.

Chapter 3 treats the general procedure of FEM. The following topics are dealt with: basic elementary shapes, different types of elements, node locations, node numbering schemes to reduce computer costs, and selection of a polynomial form of interpolation functions and their convergence requirements. Linear interpolation polynomials are considered in terms of both global and local coordinates for one-, two-, and three-dimensional elements. Next is a discussion of the variational approach (Rayleigh-Ritz) and the weighted residual approach. The chapter concludes with assembly of element matrices, computer implementation, incorporation of boundary conditions, and solution of finite element equations.

The next chapter is interesting because the author explains in simple language the higher order elements, including quadratic and cubic elements. They are expressed in terms of natural coordinates for one-, two-, and three-degree elements plus the classical interpolation polynomials; i.e., Lagrange interpolation functions and zero, first, and second order Hermitian functions. A discussion of isoparametric elements includes definitions, shape functions, and curved sided elements in both two and three dimensions.

Chapter 5 has to do with solid and structural mechanics. The basic equations of solid mechanics are given, as are internal and external equilibrium equations, stress-strain and stress-displacement relations, compatibility equations, and stress-strain relations for anisotropic materials. An analysis of space truss and frame elements plus beam elements is given. Plate stress analysis includes triangular and rectangular elements. The chapter concludes with an analysis of three-dimensional problems using tetrahedronal and hexahedronal elements (8 and 20 nodes) and an analysis of solids of revolution using an axisymmetric ring element. The reviewer would have preferred more applications of the isoparametric elements in plate problems.

The next chapter focuses on dynamic analysis. The dynamic equations of motion and the lumped and

consistent mass concept are presented. The former is applied to frame elements, triangular membranes, and bending and tetrahedronal elements.

The concluding sections on free vibrational analysis treat condensation of the eigenvalue economizer and applications to natural frequencies of a square cantilever plate, a cantilevered box beam, and dynamic response calculations. The calculations include derivations of the uncoupling of equations of motion for both damped and undamped systems. The reviewer feels the section on consistent mass matrices is excellent but believes the author should have included the Wilson method and the Houbolt and Newmark time integration schemes.

Chapter 6 contains an excellent discussion and description of heat transfer analysis using FEM. The energy balance equation, rate equations (conduction, radiation, and convection) and direct applications using Galerkin's method and the variational approach are given. One-dimensional (straight and tapered fin) and two-dimensional heat transfer are described. The chapter concludes with a short section on unsteady heat transfer problems.

The next chapter introduces a new application of FEM; i.e., fluid mechanics and irrotational flow. Topics include steady inviscid incompressible median, incompressible viscous flow and stream function formulation flow in porous medium, incompressible viscous flow, and flow of non-Newtonian fluids. This excellent chapter will be of interest to those who want to apply FEM to fluid mechanics.

The last chapter considers applications of FEM to a number of subjects; i.e., distribution of electrical potential, magnetostatics, electrostatics, acoustics, and seepage flow. Heat conduction, fluid-film lubrication, and torsion of prismatic shafts are emphasized.

This excellent book contains a large number of computer programs and a good table of nomenclature. The examples are accompanied by adequate explanations. FEM could have been applied to fracture mechanics, and a short discussion of hybrid elements would have been useful. The section on applications of FEM to acoustics is too brief and should have been expanded. The book should be a good reference book to the student as well as the experienced user.

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Scotia, NY 12302

DEFORMATION AND FRACTURE OF SOLIDS

R.M. Caddell
Prentice-Hall, Inc., Englewood Cliffs, NJ
1980, 307 pages

This ambitious book deals with a wide range of loosely related subjects. It is, in fact, difficult to understand why the author write it.

Chapter 1 deals with the subject of stress but offers no explanation of, definition of, or significance of the concept of stress. The first paragraph lacks sufficient information for either the casual reader or serious student as to the intentions of the author. The stress tensor is defined; then stress equations of equilibrium are derived, as are stress equations of transformation. Stress invariants are introduced and Mohr's circle is defined; substantial space is devoted to various ways to utilize Mohr's circle concepts.

The second chapter is much like Chapter 1 in that the reader must proceed through the text in a vacuum as to the significance of the subject. Both two- and three-dimensional strain states are defined in tensor form. The strain equations of transformation are derived, and Mohr's strain circle is presented. The concepts of engineering and true strain are developed.

Chapter 3 develops equations for linearly related stress and strain; i.e., the constitutive relations and the commonly used elastic constants, E, D, G, and B. Mohr's circles of stress and strain are related. The chapter ends with strain energy conceptualization and an allusion to two special cases: plane stress and plane strain.

Chapter 4 develops the extended stress-strain relationships for plastically deformed solids. Three general-

ized approaches are offered. Plastic deformation modeling is discussed and several different models are developed. Good descriptions of yield locus, yield surface, and yield criteria are given, as are visual representations of stress state/yield criteria. Plastic stress-strain relationships (flow rules) and a few summary observations are followed by introductions to yield surfaces, normality, and plastic work. Modified Mohr's circles for stress and strain are discussed briefly. The brevity is not because these discussions are better than earlier ones. These two chapters are clear and well written.

Chapter 5 is a side issue containing a detailed discussion of a tensile test with penetrating analyses and commentary. The chapter is superb, but the reviewer thinks that most of the comments should have appeared earlier in the book. The instructor might well present this chapter twice. Work-hardening concepts, biaxial plastic tension, ductility, and plastic plane strain compression concepts are also presented.

Chapter 6 introduces time-dependent stress and strain behavior (viscoelasticity). The usual linear models are presented, and their mathematical behavior is developed.

Chapter 7 introduces another approach to solids deformational behavior; i.e., dislocation theory. Unlike earlier chapters, the reasons for this are given. The need for this microscopic approach as opposed to the macroscopic (continuum) approach described earlier is stated. Atomic crystal spacing mechanics and various dislocation models that describe the imperfections in such crystals are presented. Burger's vector concept is used together with displacement and strain concepts to illustrate glide and shear strains. Energy concepts, Frank Reade sources of dislocations, and climb and cross-slip models are developed. Macroscopic behavior is shown to be related to these microscopic behavioral mechanisms. The Bauschinger effect, recovery, particle strengthening, microcrack formation, yield point, and strain aging are shown to be macroscopic effects of submicroscopic dislocation model behaviors. The chapter is good despite its brevity but would have benefited from a more extensive description of the relationships of these concepts to others in the book.

Chapter 8, which is one of the longest chapters in the book, deals exclusively with linear elastic fracture mechanics. Its position -- after dislocation theory -- is well thought out, despite the fact that linear elastic fracture mechanics can be derived directly from continuum mechanics concepts of Chapters 1, 2, and 3. The chapter begins with a discussion of brittle and ductile theories and relates them to the tensile test, dislocation theories, and Griffith's crack propagation theory. The concept of linear elastic fracture mechanics is developed from Griffith's theory and strain energy equilibrium considerations. Several analytical expressions are presented for various crack shapes and orientations embedded in various stress situations. Various related topics including Gurney's approach, crack stability, and size effect are treated. The chapter concludes with a variety of examples and problems for students.

Chapter 9 pursues the subject of composite materials and briefly and inadequately treats rules of mixtures, discontinuous fiber composites, and some general approaches to the failures of continuous, oriented fiber lamina. The references at the end of this section are not satisfactory for the serious student who wants to pursue the subject more deeply. Several better texts are available for further study.

The concluding chapter deals with the subject of fatigue. Several factors that influence fatigue are treated; others are not. Such major topics as cumulative fatigue damage, Goodman design curves, Gerber's Parabolas, and fatigue notch theories are only briefly presented. The chapter concludes with a minor attempt to connect fatigue crack propagation with fracture mechanics (L.E.F.M.) and an extremely short fracture surface analysis.

Overall the book fails to deal adequately with several aspects of material failure behavior that would have to be presented by the instructor. The inadequate references must also be supplemented by the instructor. On the other hand, the book contains most of the basic equations and analyses necessary for those individuals interested in material failure analysis.

K.E. Hofer
L.J. Broutman & Associates, Ltd.
3424 South State Street
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MEANINGFUL ENGINEERING SCIENCE

S.H. Rutherford
Mechanical Engineering Publications, Ltd., London
1980, 210 pages

The author's purpose in writing this book was to present clearer explanations of certain mechanical and physical phenomena and devices than are generally available in conventional texts. The principal benefit of this book is that conscientious instructors might want to use it as an extra measure in classroom lectures. All of the material described is available elsewhere, and the book does not serve well as a reference text. The general topics include examples from kinematics, kinetics, hydrodynamics, strength of materials, aerodynamics, mathematics, electricity, thermodynamics, and inelastic behavior of materials. Obviously the reader is expected to have an extensive background.

It is an interesting book. The two-tide explanation is superior to that presented classically by Lamb in Hydrodynamics. Other examples and topics include the gyroscope, coriolis acceleration, debunking of the perpetual motion machine, Euler buckling, lap joints, and cyclone wind motion.

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SHORT COURSES

JUNE

VIBRATION AND SHOCK SURVIVABILITY, TESTING, MEASUREMENT, ANALYSIS, AND CALIBRATION

Dates: June 4-8, 1984
Place: Santa Barbara, California
Dates: August 27-31, 1984
Place: Santa Barbara, California
Dates: September 17-21, 1984
Place: Ottawa, Ontario
Dates: October 15-19, 1984
Place: New York, New York
Dates: November 5-9, 1984
Place: San Francisco, California

Objective: Topics to be covered are resonance and fragility phenomena, and environmental vibration and shock measurement and analysis; also vibration and shock environmental testing to prove survivability. This course will concentrate upon equipments and techniques, rather than upon mathematics and theory.

Contact: Wayne Tustin, 22 East Los Olivos Street, Santa Barbara, CA 93105 - (805) 682-7171.

VIBRATION DAMPING

Dates: June 17-21, 1984
Place: Dayton, Ohio

Objective: The utilization of the vibration damping properties of viscoelastic materials to reduce structural vibration and noise has become well developed and successfully demonstrated in recent years. The course is intended to give the participant an understanding of the principles of vibration damping necessary for the successful application of this technology. Topics included are: damping fundamentals, damping behavior of materials, response measurements of damped systems, layered damping treatments, tuned dampers, finite element techniques, case histories, problem solving sessions.

Contact: Michael L. Drake, Jessee Philips Center 36, 300 College Park Avenue, Dayton, OH 45469 - (513) 229-2644.

MECHANICS OF HEAVY-DUTY TRUCKS AND TRUCK COMBINATIONS

Dates: June 25-29, 1984
Place: Ann Arbor, Michigan

Objective: This course describes the physics of heavy-truck components in terms of how these components determine the braking, steering, and riding performance of the total vehicle. Covers analytical methods, parameter measurement procedures, and test procedures, useful for performance analysis, prediction and design.

Contact: Engineering Summer Conferences, 200 Chrysler Center, North Campus, University of Michigan, Ann Arbor, MI 48109 - (313) 764-8490.

JULY

FIELD INSTRUMENTATION AND DIAGNOSTICS

Dates: July 16-19, 1984
Place: Houston, Texas
Dates: September 18-21, 1984
Place: Edmonton, Alberta, Canada
Dates: December 3-6, 1984
Place: Houston, Texas

Objective: To provide a balanced introduction to diagnostic instrumentation and its applications for evaluating rotating machinery behavior. The seminar also covers fundamental rotating machinery behavior and some of the more common machinery malfunctions. It includes a lab session with workshops on

data acquisition instrumentation, balancing, oil whirl/whip and rubs, and monitor system calibration.

Contact: Bob Grissom, Customer Training Department, Bently Nevada Corporation, P.O. Box 157, Minden, NV 89423 - (702) 782-9315.

FINITE ELEMENTS IN MECHANICAL AND STRUCTURAL DESIGN B: DYNAMIC AND NONLINEAR ANALYSIS

Dates: July 23-27, 1984
Place: Ann Arbor, Michigan
Objective: Covers vibration, material nonlinearities and geometric nonlinearities. Includes normal modes, transient response, Euler buckling and heat conduction. Attendees use personal computers to develop models of several problems and use MSC/NASTRAN in laboratory sessions.

Contact: Engineering Summer Conferences, 200 Chrysler Center, North Campus, University of Michigan, Ann Arbor, MI 48109 - (313) 764-8490.

DESIGN AND ANALYSIS OF ENGINEERING EXPERIMENTS

Dates: July 30 - August 10, 1984
Place: Ann Arbor, Michigan
Objective: Recent developments in the field of testing, methods for designing experiments, interpretation of test data, and procedures for better utilization of existing data. Design of experiments with small numbers of test pieces and runs with high dispersion are emphasized. Obtaining maximum information from limited data is stressed.

Contact: Engineering Summer Conferences, 200 Chrysler Center, North Campus, University of Michigan, Ann Arbor, MI 48109 - (313) 764-8490.

AUGUST

MACHINERY INSTRUMENTATION AND DIAGNOSTICS

Dates: August 6-10, 1984
Place: Carson City, Nevada
Objective: To assist industry personnel in solving problems associated with machinery vibration programs. Topics include a review of transducers and monitoring systems, application of relative and seismic transducers to various types of rotating machinery, data acquisition and reduction instruments and techniques, and machinery malfunction diagnosis. The seminar includes a lab session with workshops on data acquisition instrumentation, balancing, oil whirl/whip and rubs, and monitor system calibration.

Contact: Bob Grissom, Customer Training Department, Bently Nevada Corporation, P.O. Box 157, Minden, NV 89423 - (702) 782-9315.

MACHINERY VIBRATION ANALYSIS

Dates: August 14-17, 1984
Place: New Orleans, Louisiana
Dates: October 9-12, 1984
Place: Houston, Texas
Dates: November 27-30, 1984
Place: Lisle, Illinois
Objective: In this four-day course on practical machinery vibration analysis, savings in production losses and equipment costs through vibration analysis and correction will be stressed. Techniques will be reviewed along with examples and case histories to illustrate their use. Demonstrations of measurement and analysis equipment will be conducted during the course. The course will include lectures on test equipment selection and use, vibration measurement and analysis including the latest information on spectral analysis, balancing, alignment, isolation and damping. Plant predictive maintenance programs, monitoring equipment and programs, and equipment evaluation are topics included. Specific components and equipment covered in the lectures include gears, bearings (fluid film and antifriction), shafts, couplings, motors, turbines, engines, pumps, compressors, fluid drives, gearboxes, and slow-speed paper rolls.

Contact: The Vibration Institute, 101 West 55th Street, Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

MACHINERY VIBRATION ENGINEERING

Dates: August 14-17, 1984
Place: New Orleans, Louisiana

Dates: October 9-12, 1984
Place: Houston, Texas
Dates: November 27-30, 1984
Place: Lisle, Illinois
Objective: Techniques for the solution of machinery vibration problems will be discussed. These techniques are based on the knowledge of the dynamics of machinery; vibration measurement, computation, and analysis; and machinery characteristics. The techniques will be illustrated with case histories involving field and design problems. Familiarity with the methods will be gained by participants in the workshops. The course will include lectures on natural frequency, resonance, and critical speed determination for rotating and reciprocating equipment using test and computational techniques; equipment evaluation techniques including test equipment; vibration analysis of general equipment including bearings and gears using the time and frequency domains; vibratory forces in rotating and reciprocating equipment; torsional vibration measurement, analysis, and computation on systems involving engines, compressors, pumps, and motors; basic rotor dynamics including fluid film bearing characteristics, critical speeds, instabilities, and mass imbalance response; and vibration control including isolation and damping of equipment installation.

Contact: The Vibration Institute, 101 West 55th Street, Clarendon Hills, IL 60514 - (312) 654-2254.

MODAL TESTING

Dates: August 14-17, 1984
Place: New Orleans, Louisiana
Objective: Vibration testing and analysis associated with machines and structures will be discussed in detail. Practical examples will be given to illustrate important concepts. Theory and test philosophy of modal techniques, methods for mobility measurements, methods for analyzing mobility data, mathematical modeling from mobility data, and applications of modal test results will be presented.

Contact: The Vibration Institute, 101 West 55th Street, Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

SEPTEMBER

MACHINERY INSTRUMENTATION

Dates: September 12-14, 1984
Place: Calgary, Alberta, Canada
Objective: To provide an in-depth examination of vibration measurement and machinery information systems as well as an introduction to diagnostic instrumentation. The seminar is designed for mechanical, instrumentation, and operations personnel who require a general knowledge of machinery information systems. It is a recommended prerequisite for the Machinery Instrumentation and Diagnostics Seminar.

Contact: Bob Grissom, Customer Training Department, Bently Nevada Corporation, P.O. Box 157, Minden, NV 89423 - (702) 782-9315.

OCTOBER

ELECTROEXPLOSIVES DEVICES

Dates: October 16-19, 1984
Place: Philadelphia, Pennsylvania
Objective: Topics will include but not be limited to the following: history of explosives and definitions; types of pyrotechnics, explosives and propellants; types of EEDs, explosive trains and systems, fuzes, safe-arm devices; sensitivity and functioning mechanisms; output and applications; safety versus reliability; hazard sources; lightning, static electricity, electromagnetic energy (RF, EMP, light, etc.), heat, flame, impact, vibration, friction, shock, blast, ionizing radiation, hostile environments, human error; precautions, safe practices, standard operating procedures; grounding, shorting, shielding; inspection techniques, system check-out trouble shooting and problem solving; safety devices, packaging and transportation; specifications, documentation, information sources, record keeping; tagging, detection and identification of clandestine explosives; reaction mechanisms, solid state reactions; chemical deactivation, disposal methods and problem, toxic effects; laboratory analytical techniques and instrumentation; surface chemistry.

Contact: E&P Affairs, The Franklin Research Center, 20th and Race Streets, Philadelphia, PA 19103 - (215) 448-1000.

MECHANICAL ENGINEERING (POWER GENERATION)

Dates: October 22-26, 1984

Place: Carson City, Nevada

Objective: Emphasizes the mechanisms behind various machinery malfunctions. Problems associated with rotating equipment used for power generation are highlighted. The seminar is designed for mechanical, maintenance, and machinery engineers who are involved in the design, acceptance testing, and operation of rotating machinery. Other topics include data for identifying problems and suggested methods of correction. The seminar also includes a lab session.

Contact: Bob Grissom, Customer Training Department, Bently Nevada Corporation, P.O. Box 157, Minden, NV 89423 - (702) 782-9315.

NEWS BRIEFS: news on current and Future Shock and Vibration activities and events

Call for Papers

30th ASME INTERNATIONAL GAS TURBINE CONFERENCE AND EXHIBIT
Houston, Texas
March 18-21, 1985

The 30th ASME International Gas Turbine Conference and Exhibit will be held March 18-21, 1985 at Albert Thomas Convention Center, Houston, Texas. This Conference, sponsored by The American Society of Mechanical Engineers' Gas Turbine Division, has become an increasingly prominent annual forum for the international exchange of technical and product information on gas turbines.

Papers are invited concerning all aspects of gas turbine technology, including research and development, education, systems concepts, application and operational experience. Papers of interest to gas turbine users are particularly encouraged.

Authors wishing to submit a paper should forward an abstract by July 1, 1984 to the program chairman: Howard L. Julien, Raymond Kaiser Engineers Inc., Advanced Technologies Div. BB-4, P.O. Box 23210, Oakland, CA 94623-2310.

Completed manuscripts must be received by the session organizer or technical committee chairman no later than September 1, 1984. All papers submitted will be reviewed in accordance with established ASME Gas Turbine Division policy and procedures.

For further information contact: The International Gas Turbine Center, 4250 Perimeter Park South, Suite 108, Atlanta, GA 30341 - (404) 451-1905.

ABSTRACTS FROM THE CURRENT LITERATURE

ABSTRACT CONTENTS

AVAILABILITY OF PUBLICATIONS ABSTRACTED

Government Reports:	NTIS Springfield, VA 22151 (unless otherwise indicated)
Ph.D. Dissertations:	University Microfilms International 300 N. Zeeb Rd. Ann Arbor, MI 48106
U.S. Patents:	Commissioner of Patents Washington, DC 20231
Chinese Publications (CSTA):	International Information Service, Ltd. P.O. Box 24683 ABD Post Office Hong Kong (In Chinese or in English translation)

In all cases appropriate order numbers should be used (last line of citation).

When not available in local libraries, copies of the majority of papers or articles may be obtained at Engineering Societies Center, 345 E. 47th St., New York, NY 10017, or Library of Congress, Washington, DC.

None of the publications are available at SVIC or at the Vibration Institute, except those generated by either organization.

A list of periodicals scanned in published in issues 1, 6, and 12.

MECHANICAL SYSTEMS

Difficulties in solution methodology to be used to deal with the potentially higher nonlinear rotor equations when dynamic coupling is included. A solution methodology is selected to solve the nonlinear differential equations. The selected method was verified to give good results even at large nonlinearity levels. The transfer matrix methodology is extended to the solution of nonlinear problems.

ROTATING MACHINES

(Also see No. 849)

84-784

A Practical Method for the Design of a Monitor for Weakly Damped Multimass Systems with Deterministic Measured Disturbances (Ein praktisch orientiertes Verfahren der Beobachterauslegung bei schwachgedämpften Mehrmassensystemen mit deterministischen Messstörungen)

H. Wilharm

Fortschritt-Berichte VDI-Zt., Reihe 8, No. 64 (1983), 252 pp, 59 figs, 13 tables. Summarized in VDI-Z, 125 (18), pp 759-60 (Sept 1983). Avail: VDI-Verlag GmbH, Postfach 1139, 4000 Düsseldorf 1, Germany. Price: 142 - DM

(In German)

Key Words: Turbomachinery, Monitoring techniques, Torque, Damped structures

The design of a monitor for measuring the torque of turbosets (turbine and generator) is described. The principle of the monitor is to model a segment of the system, which is excited by the same input as the real system. The measured data are compared with corresponding model data. The model of the segment is controlled by the error through monitor matrix. The estimated value of the actual system condition can be obtained from the model.

84-785

Theoretical Investigation of the Force and Dynamically Coupled Torsional-Axial-Lateral Dynamic Response of Geared Rotors

J.W. David and L.D. Mitchell

Virginia Polytechnic Inst. and State Univ., Blacksburg, VA, Rept. No. NASA-CR-173013, 33 pp (1982)

N83-34656

Key Words: Rotors, Torsional response, Axial vibration, Lateral response, Coupled response

84-786

Vibration of Cracked Shafts in Bending

A.D. Dimarogonas and C.A. Papadopoulos

Univ. of Patras, Patras, Greece, J. Sound Vib., 91 (4), pp 583-593 (Dec 22, 1983) 5 figs, 10 refs

Key Words: Shafts, Cracked media, Vibration response, Diagnostic techniques

A de Laval rotor with an open crack is investigated by way of application of the theory of shafts with dissimilar moments of inertia. Analytical solutions are obtained for the closing crack under the assumption of large static deflections and a solution is developed for a case in which the local flexibility function is found experimentally.

METAL WORKING AND FORMING

(See Nos. 973, 1013)

MATERIALS HANDLING EQUIPMENT

84-787

Noise Reduction of Chain Conveyor. Volume 2

A. Galaitsis, R. Madden, and D. Anderson

Bolt Beranek and Newman, Inc., Cambridge, MA, Rept. No. BBN-5112, BUMINES-OFR-171-83, 63 pp (Feb 1983)

PB83-262634

Key Words: Conveyors, Chains, Noise reduction

This report briefly reviews the aboveground tests performed on a Jeffrey 120M conveyor that were documented in volume 1 of this study, and describes the performance of treatments implemented on underground equipment. The noise level at the operator's position in the aboveground test facility was reduced from 101.5 to 91 dBA using treatments with satisfactory aboveground durability.

STRUCTURAL SYSTEMS

BUILDINGS

84-788

Dynamic Response of High-Rise Building Subject to Wind Excitation

M.A.M. Torkamani and E. Pramono

Dept. of Civil Engrg., Univ. of Pittsburgh, Pittsburgh, PA, Rept. No. SETEC-CE-84-002, NSF/CEE-83200, 109 pp (Sept 1983)

PB84-112374

Key Words: Buildings, Multistory buildings, Wind-induced excitation, Finite element technique, Computer programs

The dynamic responses of tall buildings subject to wind loadings are investigated. A finite element model for a three-dimensional, multi-story building is used to consider the contributions of every member, including beams, columns, panels, and shear walls. The fundamental meteorological behavior applicable to response analysis of tall buildings is described.

84-789

Line Source and Site Characterizations for Defining the Sound Transmission Loss of Building Facades

F.F. Rudder, Jr.

Bldg. Acoustics Group, Ctr. for Bldg. Tech., Natl. Bureau of Standards, Washington, DC 20234, J. Sound Vib., 91 (3), pp 403-424 (Dec 8, 1983) 11 figs, 20 refs

Key Words: Buildings, Sound transmission loss

An analytical model is presented for defining the sound transmission loss of building facades exposed to noise from line sources. The model describes the non-diffuse sound field incident upon the facade in terms of both source and site parameters. The effects of facade orientation relative to the line source and the sound propagation with distance are introduced as a single term in the definition of the facade sound transmission loss. Numerical results are presented.

84-790

Building Critical-Mode Control: Nonstationary Earthquake

J.N. Yang and M.J. Lin

The George Washington Univ., Washington, DC 20052, ASCE J. Engrg. Mech., 109 (6), pp 1375-1389 (Dec 1983) 12 figs, 2 tables, 2 refs

Key Words: Buildings, Seismic excitation, Random excitation, Active vibration control

A method of optimal open-loop critical-mode control is applied to building structures excited by an earthquake that is modeled as a nonstationary random process. The time dependent statistics of building response quantities and required active control forces are presented. Monte Carlo simulations for building response quantities with or without active control systems are performed to demonstrate the behavior of buildings subject to earthquake excitations.

84-791

Stochastic Response of Yielding Multistory Structures

L.D. Lutes and Tysh Shang Jan

Rice Univ., Houston, TX, ASCE J. Engrg. Mech., 109 (6), pp 1403-1418 (Dec 1983) 9 figs, 12 refs

Key Words: Buildings, Multistory buildings, Viscous damping, Stochastic processes

The random response of bilinear hysteretic yielding systems subjected to a stationary Gaussian white noise excitation is studied. The responses considered are the root mean square interfloor displacements of yielding multidegree-of-freedom (MDF) shear beam type building structures. An analytical method to approximate the response levels is presented, as well as fairly extensive simulation results. Nearly elastoplastic 2DF, 4DF, and 10DF systems with small viscous damping are studied.

84-792

Distribution and Correlation of Dynamic Wind Loads

T.A. Reinhold

Morrison Hershfield Ltd., Edmonton, Alberta, Canada, ASCE J. Engrg. Mech., 109 (6), pp 1419-1436 (Dec 1983) 11 figs, 19 refs

Key Words: Buildings, Multistory buildings, Wind-induced excitation

Types of aeroelastic and elastic wind tunnel models available for measuring fluctuating wind loads on tall buildings are described together with some of their advantages and limitations. A new technique for using numerous pressure transducers to directly measure these fluctuating wind loads is presented. In this technique analog circuits are used to sum individual pressure measurements in obtaining records which represent loads over segments of the model or over the entire model. Recent tests using the technique are described and sample results are shown.

TOWERS

(See No. 812)

FOUNDATIONS

(Also see No. 807)

84-793

Rocks Behaviour under Periodic Load

C. Radu, I. Rugină, G. Winter, and V. Winter

Center of Earth Physics and Seismology, Bucharest -- Măgurele, Rev. Roumaine Sci. Tech., Mecanique Appl., 28 (2), pp 201-209 (Mar/Apr 1983) 11 figs, 13 refs

Key Words: Rocks, Periodic response

This paper is devoted to the study of rock behavior during compressive uniaxial periodic load under variable stresses. Three periodic loading modes are considered. Experimental results show that the rock microfracturing process is statistically similar to an earthquake generating process.

84-794

Effects of Transient Foundation Uplift on Earthquake Response of Structures

Chik-Sing Yim and A.K. Chopra

Earthquake Engrg. Res. Ctr., Univ. of California, Berkeley, CA, Rept. No. UCB/EERC-83/09, NSF/CEE-83014, 137 pp (June 1983)

PB83-261396

Key Words: Seismic design, Foundations

The objective of this study is to develop a better understanding of the effects of transient foundation uplift on response of structures, so that the related reduction in earthquake forces can be considered in the design of structures. The mathematical models chosen are simple, but incorporate the most important effects of soil flexibility and realistic mechanics of uplifting and impact.

84-795

Foundation Piles: Design, Emplacement, and Performance. 1973 - September 1983 (Citations from the BHRA Fluid Engineering Data Base)

NTIS, Springfield, VA, 108 pp (Sept 1983)

PB83-872697

Key Words: Bibliographies, Foundations, Pile structures

This bibliography contains 149 citations concerning piles and pileworks design, emplacement or sinking, and behavior in various soils, environments, locations, and applications. Piles, pile driving techniques and equipment, and high and low pile structures are considered. Dynamic response of piles and pileworks to various conditions such as wind, wave, ice, seismicity, soil instability, and long term displacement is also examined.

UNDERGROUND STRUCTURES

84-796

Dynamic Behavior of Underground Structures

G.D. Manolis

State Univ. of New York, Buffalo, NY 14260, Shock Vib. Dig., 15 (11), pp 7-18 (Nov 1983) 113 refs

Key Words: Underground structures, Reviews

This article has two purposes: a) to provide a brief historical perspective to the general subject of dynamic behavior of underground structures and b) to summarize the work done in this area during the last few years. Underground structures can be close to the surface or deeply buried and can be subjected to harmonic, shock, or seismic excitations. Experimental, analytical, and numerical methods of approach are discussed.

HARBORS AND DAMS

84-797

Seismic Design, Analysis, and Remedial Measures to Improve Stability of Existing Earth Dams

W.F. Marcuson, III and A.G. Franklin
Army Engineer Waterways Experiment Station, Vicksburg, MS, Rept. No. WES/MP/GL-83-23, 23 pp (Sept 1983)
AD-A133 437

Key Words: Dams, Seismic design

This report discusses the seismic design of new embankment dams and analysis of existing dams, and possible courses of action to mitigate seismic hazards in the event that analysis indicates unsatisfactory conditions. Also discussed are the use of pseudostatic stability analysis and appropriate seismic coefficients. Several courses of action to deal with unsatisfactory conditions have been identified as being potentially feasible.

84-798
Effects of Reservoir Bottom Absorption on Earthquake Response of Concrete Gravity Dams
G. Fenves and A.K. Chopra
Univ. of California, Berkeley, CA, Earthquake Engrg. Struc. Dynam., 11 (6), pp 809-829 (Nov/Dec 1983) 10 figs, 2 tables, 13 refs

Key Words: Dams, Concretes, Seismic response

A procedure is presented to analyze the response of concrete gravity dams due to horizontal and vertical earthquake ground motion components considering dam-water interaction and partial absorption of hydrodynamic pressure waves at the reservoir bottom into the foundation medium. The effects of reservoir bottom absorption on the hydrodynamic force on a rigid dam are examined. The harmonic response of an idealized dam cross-section is presented for a wide range of parameters characterizing the properties of the dam, the impounded water and the foundation medium.

PRESSURE VESSELS

(See No. 989)

POWER PLANTS

(Also see Nos. 881, 934, 989, 998, 999, 1003)

84-799
Wave Energy Conversion with an Oscillating Water Column on a Fixed Offshore Platform
W.L. Green, J.J. Campo, J.E. Parker, J.A. Miller, and J.B. Miles
Univ. of Missouri-Columbia, Columbia, MO, J. Energy Resources Tech., Trans. ASME, 105 (4), pp 487-491 (Dec 1983) 2 figs, 1 table, 10 refs

Key Words: Power plants (facilities), Wave energy, Wave forces

The purpose of this study is to examine the feasibility of practical wave energy conversion using an oscillating water column and a counter-rotating turbine on a fixed offshore platform. A linear array of such platforms along a coastline, with the power transmitted ashore by submarine cable, constitutes the type of wave energy powerplant discussed.

84-800
Vibration-Damage Testing of Thermal-Barrier Fibrous Insulation
W.E. Black and W.S. Betts
GA Technologies, Inc., San Diego, CA, Rept. No. GA-A-16825, CONF-830805-26, 9 pp (Apr 1983) (Intl. Conf. Struc. Mechanics in Reactor Tech., Chicago, IL, Aug 22, 1983)
DE83011225

Key Words: Nuclear reactor components, Thermal insulation, Vibration tests, Acoustic tests

A long-term, multi-phase program to determine the vibration characteristics of thermal barrier components leading to qualification of assemblies for high temperature gas-cooled reactor service is discussed.

84-801
Flow-Induced Vibration and Instability of Some Nuclear-Reactor-System Components
S.S. Chen
Argonne Natl. Lab., Argonne, IL, Rept. No. CONF-830805-25, 11 pp (1983) (Intl. Conf. Struc. Mechanics in Reactor Tech., Chicago, IL, Aug 22, 1983)
DE83010751

Key Words: Nuclear reactor components, Fluid-induced excitation

The high-velocity coolant flowing through a reactor system component is a source of energy that can induce component

vibration and instability. Flow-induced-vibration studies have been performed in many countries. Significant progress has been made in understanding the different phenomena and development of design guidelines to avoid damaging vibration. An overview of recent progress in several selected areas is presented.

84-802

Analysis of the HDR Blowdown Experiment Using a Weakly Coupled Fluid-Structural Dynamic Method

M.K. Au-Yang, J.R. Biller, G.M. Mignogna, and F.M. Rundle
Utility Power Generation Div., Babcock & Wilcox, P.O. Box 1260, Lynchburg, VA 24505, Nucl. Engrg. Des., 76 (2), pp 95-109 (Nov 1983) 21 figs, 2 tables, 16 refs

Key Words: Nuclear reactors, Interaction: structure-fluid

The methodology and results of a German HDR blowdown experiment are presented. The test is designed as a full-scale PWR LOCA simulation. The analysis is based on a weakly coupled structural priority approach to the coupled fluid-structure problem. The hydraulic forcing function and the hydrodynamic mass matrix form the input basis to the structural dynamic analysis. Analytical results are described and compared favorably with measurements.

84-803

Evaluation of Fluid-Modeling Techniques in the Seismic Analysis of LMFBR Reactors

D.C. Ma, J. Gvildys, and Y.W. Chang
Argonne Natl. Lab., Argonne, IL, Rept. No. CONF-831047-39, 10 pp (1983) (Pres. at the Amer. Nuclear Soc. Winter Mtg., San Francisco, CA, Oct 30, 1983)
DE83014679

Key Words: Nuclear reactors, Interaction: structure-fluid, Seismic analysis, Mathematical models

The objectives of this study are to examine the validity of the two commonly used fluid modeling techniques; i.e., simplified added mass method and lumped mass method and to provide some useful information on the treatment of fluid in seismic analysis. The validity of these two methods of analysis is examined by comparing the calculated seismic responses of a fluid-structure system based on these two methods with that calculated from a coupled fluid-structure interaction analysis in which the fluid is treated by continuum fluid elements.

84-804

Detection of Fuel Element Vibration at KNK II

F. Mitzel, W. Vaeth, and S. Ansari
Kernforschungszentrum Karlsruhe GmbH, Fed. Rep. Germany, Inst. fuer Netronenphysik und Reaktortechnik, Rept. No. KFK-3379, 107 pp (Nov 1982)
DE83750651
(In German)

Key Words: Nuclear reactor components, Nuclear fuel elements, Fluid-induced excitation

The reactivity signal of the KNK II plant shows almost harmonic oscillations of delta rho $<=$ 0.5 c. Very sensitive correlation measurements, made during the regular plant operation with the normal plant instrumentation, revealed that these oscillations are associated with individual fuel elements. Auxiliary measurements under various operational conditions and theoretical considerations show that this phenomenon is probably caused by flow-induced mechanical vibration. Efforts have been made to classify the flow-induced vibration and to identify the particular excitation mechanism.

84-805

Seismic Instrumentation

K. Maubach
Kernforschungszentrum Karlsruhe GmbH, Fed. Rep. Germany, Schule fuer Kerntechnik, Rept. No. INIS-fm-7936, CONF-821039-28, 19 pp (1982) (IAEA Intl. Symp. on Nuclear Power Plant Control and Instrumentation, Munich, Fed. Rep. Germany, Oct 11, 1982)
DE83780747

Key Words: Nuclear power plants, Seismic design, Seismic response, Measuring instruments, Measurement techniques

This paper deals with types of seismic instrumentation, their location in a nuclear power plant, and their sensitivity and calibration. The evaluation of measured data and plant operation after an earthquake are also dealt with.

84-806

Dynamic Responses of Fuel and Target Assemblies of a Production Reactor

D.A. Crowley and W.F. Yau
Savannah River Lab., E.I. duPont de Nemours and

Co., Aiken, SC, Rept. No. DP-MS-82-78, CONF-830805-37, 18 pp (1983) (Intl. Conf. Struc. Mechanics in Reactor Tech., Chicago, IL, Aug 22, 1983)
DE83012050

Key Words: Nuclear reactors, Qualification tests, Transportation effects, Seismic tests

As part of the qualification research aimed at assuring safe operation of the production reactors at the Savannah River Plant, the dynamic responses of internal reactor components are being analyzed. One such program investigates the responses of heavy fuel and target assemblies undergoing two types of loading -- the disturbances due to the motion of machines that transport the assemblies to and from the reactor, and the seismic loading due to a design basis earthquake during reactor operation.

84-807

Assessment of Soil-Structure Interaction Effects Based on Simple Modes (PWR; BWR)

A.J. Philippacopoulos and C.A. Miller

Brookhaven Natl. Lab., Upton, NY, Rept. No. BNL-NUREG-32663, CONF-830805-15, 15 pp (1983) (Intl. Conf. Struc. *Mechanics in* Reactor Tech., Chicago, IL, Aug 22, 1983)
DE83010461

Key Words: Interaction: soil-structure, Nuclear reactors, Seismic response

Soil-structure interaction effects are investigated using a simple mathematical model which employs three degrees-of-freedom. The foundation is approximated by a homogeneous, isotropic, elastic half-space. Harmonic functions and a recorded earthquake are used to represent the free-field input motion. The findings reported herein can be used for the interpretation of the results of soil-structure interaction analyses of nuclear plant structures that are performed with available computer codes.

84-808

Effects of Core Barrel on Vessel Seismic Loadings (LMFBR)

D.C. Ma, J. Gvildys, and Y.W. Chang

Argonne Natl. Lab., Argonne, IL, Rept. No. CONF-830805-27, 15 pp (1983) (Intl. Conf. on Structural Mechanics in Reactor Tech., Chicago, IL, Aug 22, 1983)
DE83010728

Key Words: Nuclear reactors, Seismic response

Reliability of reactor systems under seismic events is a major concern for the safety of the nuclear power plants. This paper deals with the effects of the core barrel on the seismic response of reactor tanks. The main emphases are the effects of core barrel on the free-surface wave height and the fluid coupling effects between the core barrel and primary tank.

84-809

Use of Steel Fiber Reinforced Concrete in Containment and Explosive-Resistant Structures

C.H. Henager

Battelle Pacific Northwest Labs., Richland, WA, The Interaction of Non-Nuclear Munitions with Structures: Symp. Proc. U.S. Air Force Academy, CO, May 10-13, 1983, Part 1, pp 199-203 (AD-A132 115)
AD-P001 743

Key Words: Nuclear reactor containment, Explosion effects, Fiber composites, Reinforced concrete

The results of several investigations of steel fiber reinforced concrete (SFRC) under explosive loading are presented. Tests using high explosives were performed to compare reinforced concrete slabs using conventional concrete to similar slabs using SFRC. Use of SFRC in a reactor containment structure is reviewed. Design aids and potential applications of SFRC for blast resistance in structures are listed.

84-810

Dynamic Response of a Large Loop-Type LMFBR Head Closure to HCDA Loads

R.F. Kulak and C. Fiala

Argonne Natl. Lab., Argonne, IL, Rept. No. CONF-830805-32, 18 pp (1983) (Intl. Conf. Struc. Mechanics in Reactor Tech., Chicago, IL, Aug 22, 1983)
DE83010573

Key Words: Nuclear reactors, Containment structures, Impact response

An investigation is presented on the dynamic structural response of the primary vessel's head closure to slug impact

loadings generated from a 1000 MJ source term. A decoupled analysis of this fluid-structure interaction problem was performed. A two-dimensional axisymmetric hydrodynamic computation was performed to define the head loadings. A three-dimensional structural response computation was made to assess the containment capability of the head closure.

84-811

Analysis of HCDA Loads and Containment Response of a Large Loop-Type LMFBR

C.Y. Wang, W.R. Zeuch, Y.W. Chang, and S.H. Fistedis

Argonne Natl. Lab., Argonne, IL, Rept. No. CONF-830805-34, 20 pp (1983) (Intl. Conf. Struc. Mechanics in Reactor Tech., Chicago, IL, Aug 22, 1983)
DE83010571

Key Words: Nuclear reactors, Containment structures, Impact response

As part of a comprehensive safety study, analyses are presented on the hydrodynamic loads and containment response of a large loop-type LMFBR subjected to an HCDA of a 1000 MJ energy release. The reference reactor consists of a primary vessel, a head cover, and various complex internals. Three calculations are performed with the ANL hybrid Lagrangian-Eulerian containment code, ALICE-II.

OFF-SHORE STRUCTURES

84-812

State-of-the Art Report on Guyed Tower Platforms

Brown and Root Development, Inc., Houston, TX, Rept. No. NBS-GCR-83-443, 128 pp (1983)
PB83-253005

Key Words: Drilling platforms, Off-shore structures, Towers, Guyed structures

This state-of-the-art report reviews general concepts, design considerations, the modeling of dynamic and fatigue behavior, methods of analysis, and problems of fabrication and installation, pertaining to offshore guyed tower platforms. In addition, a list of references is provided, complemented by a bibliography on dynamic problems in platform design.

84-813

Finite Element Analysis to Determine the Eigenfrequencies and Natural Shapes of Vibration of a Steel Offshore Platform

R. Dietrich

GKSS - Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude, Fed. Rep. Germany, Rept. No. GKSS-82/E/49, 49 pp (1982)
DE83750995
(In German)

Key Words: Drilling platforms, Offshore structures, Steel, Natural frequencies, Mode shapes, Finite element technique

An analysis is presented for frequencies and natural shapes of vibration for a steel offshore platform. The analysis is performed using the finite element method. The basic concepts of this method are explained. The thirty lowest frequencies are stated. For these frequencies the natural shapes of vibration are demonstrated in three-dimensional form.

84-814

Measurements of Wave and Drift Induced Line Forces and Motions on Board the Semi-Submersible DB-100

L.J. Wevers

Instituut TNO voor Werktuigkindige Constructies, Delft, The Netherlands, Rept. No. 5015202-83-2, 14 pp (Mar 1983)
PB83-251959

Key Words: Drilling platforms, Off-shore structures, Wave forces

Static and dynamic line forces, along with motion and strength behavior of the platform, are of most importance when a floating platform is working at sea in rough weather conditions. Extensive calculations and model testing are carried out in the early stages of design phase of platforms and barges. A general description is given of measurements carried out at the North Sea on the Derrick Barge 100.

84-815

Laboratory Study of Submerged Multi-Body Systems in Earthquakes

G.R. Ansari

Earthquake Engrg. Res. Ctr., Univ. of California,

Berkeley, CA, Rept. No. UCB/EERC-83/08, 381 pp (June 1983)
PB83-261842

Key Words: Off-shore structures, Seismic response

A theoretical and laboratory study of multi-body and fluid interactions, subject to a set of boundary conditions, constraints and excitations is presented. The scales of motion along with various parameters found in the ocean environment are investigated. The behavior of ocean based systems subject to earthquake excitations is discussed. A multi-variable feedback control system is developed to model the behavior of multi-body fluid interactions. A successive superposition technique is presented using efficiency functions.

84-816

Load Spectra for Slender Offshore Structures in Waves and Currents

R.E. Taylor and A. Rajagopalan

University College London, London WC1E 7JE, UK, Earthquake Engrg. Struc. Dynam., 11 (6), pp 831-842 (Nov/Dec 1983) 2 figs, 3 tables, 10 refs

Key Words: Off-shore structures, Wave forces, Power spectral density

The influence of currents on the wave induced dynamic response of offshore structures with slender members is assessed by deriving appropriate load spectra. The analysis permits the implications of the modified Morison equation to be examined, and suggests that methods of equivalent linearization commonly employed may yield unconservative results. An alternative formulation is proposed, in which the equations of motion are linear in the structural kinematics but the nonlinear dependence of drag force on fluid particle motions is retained.

VEHICLE SYSTEMS

GROUND VEHICLES

(Also see Nos. 831, 841, 976, 977)

84-817

Dynamic Analysis to Establish Normal Shock and Vibration of Radioactive Material Shipping Packages

S.R. Fields

Hanford Engrg. Development Lab., Richland, WA, Rept. No. HEDL-TME-83-18, 296 pp (Oct 1983)
NUREG/CR-2146-V3

Key Words: Containers, Shipping containers, Radioactive materials, Rail transportation, Mathematical models, Shock response, Vibration response

A model to simulate the dynamic behavior of shipping packages (casks) and their rail car transporters during normal transport conditions was developed. This model, CARDS (Cask-Rail Car Dynamic Simulator), was used to simulate the cask-rail car systems in a series of rail car coupling tests. On the basis of good agreement between calculated and measured results for these tests, it was concluded that the model has been validated as an acceptable tool for the simulation of similar systems.

84-818

A Linear Study of the Transient and Steady Turning Behaviour of Articulated Buses

F. Vlk

Dept. of Automobile Engrg., Technical Univ. of Brno, Czechoslovakia, Intl. J. Vehicle Des., 5 (1/2), pp 171-196 (Jan 1984) 28 figs, 1 table, 12 refs

Key Words: Buses, Articulated vehicles, Ride dynamics

A linear mathematical model has been developed for studying the directional responses to step steering input of two types of articulated buses. The following concepts are discussed: vehicle A with rear engine and (non-steered) trailing axle powered and vehicle B with rear engine, steered trailing axle and middle axle powered. Results of the series of sample calculations are presented with the objective of indicating the manner in which directional response characteristics are influenced by various vehicle design parameters.

84-819

Analysis of Vehicle Surge Stimulated by Accelerator Pedal Operation

T. Kohno, Y. Morimoto, and S. Iguar

Testing & Res. Div., Toyo Kogyo Co., Ltd., Hiroshima-Ken, Japan, Intl. J. Vehicle Des., 5 (1/2), pp 159-170 (Jan 1984) 9 figs, 3 refs

Key Words: Ground vehicles, Surges

An low-frequency fore-and-aft vibration of a vehicle stimulated by accelerator pedal operation was investigated by

using a mathematical model stimulating the drive train, suspension, sprung mass, seats and human body. The effect of each element was clarified and some counter-measures for the drive train and suspension were found. The effects of the input torque characteristics from the engine were also investigated.

84-820

Identification of Road/Tyre Induced Noise Transmission Paths in a Vehicle

S.K. Jha

Firestone Tire and Rubber Co., Central Res. Labs., Akron, OH 44317, Intl. J. Vehicle Des., 5 (1/2), pp 143-158 (Jan 1984) 13 figs, 3 tables

Key Words: Ground vehicles, Noise transmission, Interior noise, Noise source identification, Interaction: tire-pavement

This paper concerns an experimental study conducted to evaluate the relative importance on road/tire induced noise transmission paths in a vehicle. An instrumented vehicle with four accelerometers was run under coastdown condition.

84-821

Behaviour of Passenger Cars on Impact with Underride Guards

H.J. Beermann

Institut f. Fahrzeugtechnik, Technical Univ. of Braunschweig, W. Germany, Intl. J. Vehicle Des., 5 (1/2), pp 86-103 (Jan 1984) 22 figs, 2 tables, 13 refs

Key Words: Collision research (automotive)

Much information has been gathered on the impact behavior of passenger cars crashing against flat barriers. Thirty-four crash tests were carried out in order to measure impact forces and deformations. The quasistatic crush forces of simplified side members is calculated by approximation on the basis of many experimental results. A ratio of crash to crush forces was found from dynamic impact and static crush tests.

84-822

A Review of Railway Vehicle Performance and Design Criteria

M.H. Bhatti and V.K. Garg

Illinois Inst. of Tech., Chicago, IL, Intl. J. Vehicle Des., 5 (1/2), pp 232-254 (Jan 1984) 12 figs, 4 tables, 39 refs

Key Words: Railroad trains, Railroad tracks, Suspension systems (vehicles)

This paper reviews the fundamental criteria which affect the performance and design of railway vehicles. Various problems associated with the dynamic behavior of trains and vehicles are discussed with regard to the design of the suspension and structural systems. A brief description of track characterization, used in evaluating a vehicle's behavior, is also given.

84-823

The Handling Behaviour of Off-Road Vehicles

D.N.L. Horton and D.A. Crolla

Dept. of Mech. Engrg., Univ. of Leeds, UK, Intl. J. Vehicle Des., 5 (1/2), pp 197-218 (Jan 1984) 8 figs, 1 table, 93 refs

Key Words: Off-highway vehicles, Tire characteristics, Ride dynamics

Research relevant to the lateral dynamic behavior of off-road vehicles is reviewed. This includes work on off-road vehicle dynamics and tire forces; the lateral behavior of road vehicles is also reviewed where it is considered relevant.

84-824

The Application of Green's Function to the Investigation of the Response of Vehicle Accelerating Over Random Profile

W. Pekala and J. Szopa

The Centre of Res. and Dev. of Machines/OBRUM/ .44-101 Gliwice, ul. Toszecka 102, Poland, Rev. Roumaine Sci. Tech., Mecanique Appl., 28 (3), pp 295-310 (May/June 1983) 15 figs, 27 refs

Key Words: Ground vehicles, Random excitation, Green function

The paper presents the application of Green's function to determine the probabilistic characteristics of solutions of stochastic linear equations with coefficients variable in time, random initial conditions and random excitations. The method is applied to calculat[illegible] variances of vertical vibrations of a two-degree-of-freedom vehicle model (or suspension) accelerated over random profile.

SHIPS

(Also see No. 840)

84-825

Suppression of Propeller Noise by a Reflecting Rubber Layer (Daempning av Propellerbuller med Hjaelp av Reflekterande Gummiskikt)

R. Soederqvist and S. Soederqvist

Foersvarets Forskningsanstalt, Stockholm, Sweden, Rept. No. FOA-C-20508-E4, 25 pp (Aug 1983)

PB84-109677

(In Swedish)

Key Words: Blades, Propeller blades, Propeller noise, Marine propellers, Noise reduction, Elastomers

The pressure pulses from propeller blades are reflected by a soft layer of cellrubber applied on the underwater part of the stern of a 3000 ton coastal tanker. The soft layer is working in the near field of the propeller blades which are assumed to be simple acoustic sources.

84-826

Structure-Borne Sound Transfer Functions of a Flexible Mounting for the S-Frigates DG-SET

B. Vandergraaf

Technisch Physische Dienst TNO-TH, Delft, The Netherlands, Rept. No. TPD-208.900/3, TDCK-77633, 30 pp (Mar 16, 1983)

N83-34384

Key Words: Sound transmission, Engine mounts, Elastomers, Marine enignes

The sound transfer function of a double-shear compression mounting commonly used in diesel installations aboard ships is investigated. The frequency response of three axis linear and angular accelerations were determined for up to 1200 Hz and several loading conditions. It is shown that for some excitation directions a stiffening effect appears at 500 to 800 Hz under high static loading due to the presence of standing waves.

AIRCRAFT

(Also see Nos. 838, 844, 845, 847, 848)

84-827

Interior Noise and Vibration Measurements on Operational Military Helicopters and Comparisons with Various Ride Quality Criteria

S.A. Clevenson, J.D. Leatherwood, and D.D. Hollenbaugh

NASA Langley Res. Ctr., Hampton, VA, Rept. No. L-15598, NASA-TM-84664, 82 pp (Aug 1983)

N83-32518

Key Words: Helicopter noise, Interior noise, Interior vibration, Noise measurement, Noise-induced excitation

The results of physical measurements of the interior noise and vibration obtained within eight operational military helicopters are presented. The data were extensively analyzed and are presented in the following forms: noise and vibration spectra, overall root-mean-square acceleration levels in three linear axes, peak accelerations at dominant blade passage frequencies, acceleration exceedance data, and overall and 'A' weighted sound pressure levels.

84-828

Noise Emission of Road Vehicles: Evaluation of Some Simple Models

B.M.Favre

Institut de Recherche des Transports, Centre d'Evaluation et de Recherche des Nuisances et de l'Energie, 109 avenue Salvador Allende, 69500 Bron, France, J. Sound Vib., 91 (4), pp 571-582 (Dec 22, 1983) 6 figs, 4 tables, 9 refs

Key Words: Ground vehicles, Noise generation

The advantages of some simple monopole and dipole source models designed to reproduce the noise due to passing vehicles, the dipole sources being either in line with or perpendicular to the direction of motion, are considered. The relations between the maximum sound pressure level arising during the passing of a vehicle, the energy equivalent of the noise emitted during the same period and the acoustic power of the source are determined.

MISSILES AND SPACECRAFT

(Also see Nos. 825, 995)

84-829

Analysis and Test for Space Shuttle Propellant Dynamics

R.L. Berry, L.J. Demchak, and J.R. Tegart

Denver Div., Martin Marietta Aerospace, Denver, CO, Rept. No. MCR-81-528, NASA-CR-3683, 189 pp (June 1983)
N83-30515

Key Words: Space shuttles, Sloshing, Propellants

This report presents the results of a study to develop an analytical model capable of predicting the dynamic interaction forces on the shuttle external tank, due to large amplitude propellant slosh during RTLS separation. The report details low-g drop tower and KC-135 test programs that were conducted to investigate propellant reorientation during RTLS. In addition, the development of a nonlinear finite element slosh model is presented.

BIOLOGICAL SYSTEMS

HUMAN

84-830
Vibration Effects on the Hand and Arm in Industry
A.J. Bramer and W. Taylor, eds.
John Wiley and Sons, New York, NY, 1982, 372 pp

Key Words: Vibration excitation, Human response, Human hand

The book is based on the papers presented at the Third International Conference on Hand-Arm Vibration held in Ottawa, Canada, May 1981. Up-to-date information on the exposure of the hand to vibration, leading to "white fingers" and "dead hand" and related subjects, is discussed by acknowledged experts in the field. The papers have been grouped by subject to emphasize the measurement of vibration exposure, the effects of vibration on man, and the links between them in so-called dose-response relationships. These topics are complemented by papers treating the equally important subjects of objective tests for diagnosis, methods for reducing vibration exposure, and the legal ramifications for workers who become disabled.

84-831
Study of Heavy Truck Occupant Crash Protection: Accident Data Analyses
T.A. Ranney
Calspan Field Services, Inc., Buffalo, NY, Rept. No. CALSPAN-213, DOT-HS-806 426, 101 pp (Apr 1983)
PB83-261131

Key Words: Collision research (automotive), Trucks, Human response

Results from previously published studies and analyses of selected automated accident data files were combined to determine what percentage of heavy truck accidents involve significant injury to truck occupants, and which subsets are amenable to application of occupant crash protection technology. Details of injury causation were provided by analyses of the CPIR-B heavy truck file, which was recoded for the study. Approaches to improved occupant crash protection are discussed. Recommendations are made for the development of useable restraint systems as a first priority in countermeasure development.

84-832
Noise Abatement Investigation for the Bloodsworth Island Target Range: Data Report
R.A. Lorenz
Naval Surface Weapons Ctr., Silver Spring, MD, Rept. No. NSWC/TR-81-433, 587 pp (Nov 2, 1982)
AD-A132 146

Key Words: Noise reduction, Explosions, Human response

An extensive investigation has been carried out in an effort to reduce the impact of naval explosive exercises (both airdrops and naval gunfire) on the communities surrounding the Bloodsworth Island target range in the Chesapeake Bay. Typical range operations were monitored in the surrounding communities and the airblast measurements were correlated with weather data taken during the exercises. The main report describes the test program and the results and recommendations from the investigation.

MECHANICAL COMPONENTS

ABSORBERS AND ISOLATORS

(Also see No. 1001)

84-833
Response of Sliding Structures to Earthquake Support Motion
N. Mostaghel and J. Tanbakuchi

Dept. of Civil Engrg., Univ. of Utah, Salt Lake City, UT, Earthquake Engrg. Struc. Dynam., 11 (6), pp 729-748 (Nov/Dec 1983) 22 figs, 22 refs

Key Words: Earthquake resistant structures, Base isolation, Sliding supports, Seismic response

To study the effectiveness of sliding supports in isolating structures from damaging earthquake ground motions, a mathematical model of a single degree of freedom structure supported on a sliding foundation and subjected to the N-S component of the El Centro 1940 earthquake is considered. Spectra for absolute accelerations, relative displacements, relative-to-ground displacements, sliding displacements and residual sliding displacements are evaluated for three mass ratios, four coefficients of friction and a damping of 5 per cent critical.

84-834

Seismic Response of Torsionally Coupled Base Isolated Structures

Tso-Chien Pan and J.M. Kelly

Dept. of Civil Engrg., Univ. of California, Berkeley, CA 94720, Earthquake Engrg. Struc. Dynam., 11 (6), pp 749-770 (Nov/Dec 1983) 27 figs, 2 tables, 33 refs

Key Words: Earthquake resistant structures, Base isolation, Elastomeric bearings, Seismic response

An analytical study of the seismic response of typical base isolated structures mounted on rubber bearings is presented. Numerical results for the specific building subjected to the El Centro earthquake of 1940 are presented. Both the time history and the response spectrum modal superposition analysis were performed.

84-835

Vibration Isolation and Pressure Compensation Apparatus for Sensitive Instrumentation

R.D. Averill

NASA Langley Res. Ctr., Hampton, VA, U.S. Patent No. 4-394 819, 6 pp (July 26, 1983)

Key Words: Vibration isolation, Cryogenic systems

A system for attenuating the inherent vibration associated with a mechanical refrigeration unit employed to cryogenically cool sensitive instruments used in measuring chemical constituents of the atmosphere is described.

84-836

Active Control of Forced Harmonic Vibration in Finite Degree of Freedom Structures with Negligible Natural Damping

J.S. Burdess and A.V. Metcalfe

The University, Newcastle upon Tyne, NE1 7RU, UK, J. Sound Vib., 91 (3), pp 447-459 (Dec 8, 1983) 3 figs, 23 refs

Key Words: Harmonic response, Active vibration control, Active isolation

Methods of synthesis for vibration controllers are presented for mechanical structures where the number of actuators equals the number of modes to be controlled and for structures where the number of modes exceeds the number of actuators.

84-837

The Synthesis of an Active Flutter Suppression Law Based on an Energy Criterion

A.F. Klein

Dept. of Aeronautical Engrg., Univ. of Bristol, Aeronaut. Quart., 34 (4), pp 260-281 (Nov 1983) 11 figs, 3 refs

Key Words: Active flutter control, Energy dissipation

Theory and results are presented which show that it is questionable to base a flutter suppression law, synthesized in terms of an energy dissipation criterion, entirely on aerodynamic data. It is shown that aileron mass balance and aileron/jack impedance can adversely affect regions of stability which have been predicted using aerodynamic terms alone.

84-838

Extensional Collapse Modes of Structural Members

R.J. Hayduk and T. Wierzbicki

NASA Langley Res. Ctr., Hampton, VA, Computers Struc., 18 (3), pp 447-458 (1984) 11 figs, 1 table, 20 refs

Key Words: Energy dissipation, Structural members, Crash research (aircraft)

In recent years considerable crash-dynamics research has been devoted to improving passenger survivability in transporta-

tion vehicles of all types. One of the objectives of this research is to attenuate the load transmitted to an occupant by the structure, either by modifying structural assembly, changing geometry of its elements, or adding specific load-limiting devices to help dissipate kinetic energy.

84-839

Behaviour of Fiber Reinforced Concrete Slabs under Impact Loading

M. Huelsewig, E. Schneider, and A. Stilp
Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung e.V., Freiburg im Breisgau, Fed. Rep. Germany, Ernst-Mach-Inst., The Interaction of Non-Nuclear Munitions with Structures: Symp. Proc. U.S. Air Force Academy, CO, May 10-13, 1983, Part 1, pp 91-94 (AD-A132 115)
AD-P001 723

Key Words: Energy absorption, Reinforced concrete, Impact response

The behavior of steel fiber reinforced concrete slabs under impact loads has been investigated. The results obtained show that fracturing and spallation effects are reduced to a large extent due to high energy absorption and the increased yield strength of this material. Crater depths are comparable to those obtained using normal concrete targets. Systematic tests using different fiber types and dimensions show that the terminal ballistic behavior is strongly dependent on these parameters.

84-840

Analytical Technique for Ship-Fender Interaction

Chen-Wen Jiang and R.C. Janava
Giannotti and Associates, Inc., Annapolis, MD, Rept. No. GA-31-115-002, 20 pp (Aug 1983)
AD-A133 503

Key Words: Energy absorption, Marine fenders, Interaction: ship-fender, Time domain method

The design and selection of appropriate fender systems must consider the d· amic interaction between the ship and port or pier structure. Energy absorption characteristics of marine fender systems vary as a function of fender geometry material, load time history, load spatial distribution, local hull stiffness and frequency of loading. The dynamic interaction of marine fender systems with ship's hull is studied in time domain. The frequency dependence of the hydrodynamic coefficients is considered in the form of a simplified convolution.

84-841

A Design Procedure for the Optimization of Vehicle Suspensions

Xiao-Pei Lu, Heng-Lung Li, and P. Papalambros
Dept. of Mech. Engrg. and Applied Mechanics, Univ. of Michigan, Ann Arbor, MI, Intl. J. Vehicle Des., 5 (1/2), pp 129-142 (Jan 1984) 7 figs, 1 table, 14 refs

Key Words: Suspension systems (vehicles), Optimization, Design techniques

The optimal design of passive suspensions in a nonlinear programming formulation is considered, based upon statistical analysis of vehicle vibrations and dynamic loads. The method of monotonicity analysis is employed in the optimization study which results in a special-purpose design algorithm. The simplicity of the computations allows fast and inexpensive post-optimal parametric study and development of design charts that give the optimal quantities for any given input.

SPRINGS

84-842

A Finite Element Approach to Dynamic Characteristics of Helical Spring (Free Vibration)

T. Sawanobori and Y. Fukushima
Yamanashi Univ., 4-3-11, Takeda, Kofu-shi, Yamanashi, Japan, Bull. JSME, 26 (221), pp 2002-2009 (Nov 1983) 6 figs, 3 tables, 10 refs

Key Words: Springs, Helical springs, Free vibration, Finite element technique

The free vibration of a helical spring is analyzed by a finite element method. The mass and stiffness matrices including the effects of the pitch angle and the number of active coils are derived using the exact solution of the equations of the helical spring in static equilibrium, and the natural frequencies and associated modes are estimated numerically. The effects of the pitch angle and the number of active coils on the natural frequencies are studied closely, and it is pointed out that the effects of the pitch angle, even if minor, should be taken into consideration.

BLADES

(Also see No. 1002)

84-843

Vibration of Rotating Bladed Disc Excited by Stationary Distributed Forces

Y. Kubota, T. Suzuki, H. Tomita, T. Nagafugi, and C. Okamura
Toshiba Res. and Dev. Ctr., Ukishima-cho, Kawasaki-ku, Kawasaki, Kanagawa, Japan, Bull. JSME, 26 (221), pp 1952-1957 (Nov 1983) 14 figs, 3 tables, 2 refs

Key Words: Blades, Rotating structures, Vibration analysis

Results of theoretical and experimental studies which have been carried out to investigate the diametral vibration modes of rotating bladed discs are presented. The theoretical model is considered as a linear system and only the diameter modes are discussed.

84-844

A Simplified Model of the Influence of Blade Elastic Pitch Variations on Helicopter Rotor Flapping Dynamics

A. Rosen and Z. Beigelman
Dept. of Aeronautical Engrg., Technion Inst. of Tech., Haifa 32000, Israel, Vertica, 7 (4), pp 335-360 (1983) 7 figs, 19 refs

Key Words: Blades, Helicopters, Helicopter vibration, Rotors

The well known model of a rigid blade with spring at offset hinge, which is often used to describe the flapping dynamics of helicopter rotors, is extended to include elastic torsional pitch variations due to the torsional flexibility of the blades and the control system. The model is capable of dealing with blades which have nonuniform properties and nonuniform induced velocity distribution over the disc.

84-845

Optimal Second Harmonic Pitch Control for a Two-Bladed Articulated Rotor

L. Beiner
Mech. Engrg. Dept., Ben Gurion Univ., Beer Sheva 84120, Israel, Vertica, 7 (4), pp 321-333 (1983) 7 figs, 11 refs

Key Words: Blades, Helicopters, Helicopter vibration, Vibration control, Rotors

The paper presents an analytical solution to the problem of finding the optimal 2/rev blade feathering which minimizes the second blade lift harmonic of a given articulated rotor under a given trimmed flight condition. It is shown that the resulting minimum is zero, thus suppressing the aerodynamic component of the 2/rev hub vertical shear for a two-bladed rotor. The analysis assumes rigid blades, quasi-steady aerodynamics, linear twist, and second harmonic induced velocity and blade flapping.

84-846

Helicopter Rotor Lag Damping Augmentation through Individual-Blade-Control

N.D. Ham, B.L. Behal, and R.M. McKillip, Jr.
Dept. of Aeronautics and Astronautics, Massachusetts Inst. of Tech., Cambridge, MA 02139, Vertica, 7 (4), pp 361-371 (1983) 9 figs, 1 table, 8 refs

Key Words: Blades, Helicopters, Active control, Rotors

The paper is concerned with the application of the individual-blade-control concept to blade lag damping augmentation. To achieve this, a servomotor controls the pitch angle of the blade whose lag acceleration is sensed by two accelerometers, and an integrator yields the lag velocity which is fed back through a compensator to the blade pitch control. System performance in wind tunnel tests is described, and evidence is given of the system's ability to provide substantial additional damping to blade lag motion.

84-847

Progress in Rotor Broadband Noise Research

T.F. Brooks and R.H. Schlinker
NASA Langley Res. Ctr., Hampton, VA 23665, Vertica, 7 (4), pp 287-307 (1983) 20 figs, 90 refs

Key Words: Blades, Propeller blades, Turbulence, Noise generation, Helicopter noise

Recent research of helicopter rotor broadband noise is summarized. The noise sources considered are those due to turbulence incident to the rotor blades and those due to blade self-generated turbulence. For some mechanisms, theoretical versus experimental comparisons are given, including flyover test cases where available.

84-848

The Prediction of Helicopter Rotor Discrete Frequency Noise

F. Farassat and G.P. Succi
NASA Langley Res. Ctr., Hampton, VA 23665, Vertica, 7 (4), pp 309-320 (1983) 7 figs, 1 table, 24 refs

Key Words: Blades, Propeller blades, Noise generation, Helicopter noise

Helicopter rotor blades generate noise by several different mechanisms. The blade thickness, steady and unsteady periodic loading, blade-vortex interaction and blade-turbulence interaction generate discrete frequency noise. In the last decade, several formulations have become available that make it possible to model the complicated helicopter rotor blade motion and geometry with none of the restrictions of previous theories. Specifically, four formulations are discussed in detail in this paper. The merits and the shortcomings of these theories and their relation to each other are discussed.

BEARINGS

(Also see Nos. 854, 939, 1002)

84-849

Calculation of the Characteristics of Journal Bearings with Angular Displacement and Bending of the Shaft

H. Peeken, G. Knoll, and K. Jacoby
Rheinisch-Westfälliche Hochschule Aachen, Institut f. Maschinenelemente u. Maschinengestaltung, Aachen, Germany, VDI Forschungsheft, Nr. 617 (1983) 52 pp, 68 figs, 14 tables, 18 refs
(In German)

Key Words: Bearings, Journal bearings, Hydrodynamic response

Extensive research on the hydrodynamic behavior of plain bearings has only been carried out under the presumption that the influence of bearing and shaft deformation are disregarded. The results presented in this research booklet take into account the influence of the angular displacement and the bending of the shaft relative to its bearing on the load-carrying capacity of journal bearings in the case of pure sliding and pure squeeze velocity. The bearing characteristics are ascertained for different bearing length-to-diameter ratios as a function of the eccentricity. The calculation of the hydrodynamic pressure distribution and the bearing characteristics is achieved by employing the finite element method.

84-850

The Numerical Solution of Dynamically Loaded Elastohydrodynamic Contact as a Nonlinear Complementarity Poblem

K. Ping Oh
General Motors Res. Lab., Warren, MI, ASME Paper No. 83-Lub-12

Key Words: Elastohydrodynamic properties, Bearings

A numerical method has been developed for solving the nonlinear differential equation that arises in the elastohydrodynamic contact of bearing surfaces. This method is based upon the finite element approximation of the governing field equation, the Newton-Raphson algorithm for solving nonlinear systems, and the complementarity formulation of free-boundary problems.

84-851

Analytical Curve Fits for Solution Parameters of Dynamically Loaded Journal Bearings

P.K. Goenka
General Motors Res. Labs., Warren, MI, ASME Paper No. 83-Lub-33

Key Words: Bearings, Journal bearings, Curve fitting

A new set of analytical curve fits is presented. The set includes the two components of mobility vectors, location and magnitude of maximum film pressure, and the starting and finishing angles of the pressure curve. For an ideal journal bearing, the new curve fits give accuracy and solution detail comparable to an expensive finite element analysis, while keeping the solution time comparable to that required for the short-bearing approximation.

84-852

Dynamics of Offset Bearings: Parametric Studies

J.F. Booker and P. Olikara
Cornell Univ., Ithaca, NY, ASME Paper No. 83-Lub-39

Key Words: Bearings, Journal bearings

Offset designs seem equally promising for steady-state operation with counter-rotation of shaft and sleeve under fixed load, or (equivalently) with load rotating at half shaft speed. Both cases are elucidated through (dimensional) numerical examples and (non-dimensional) parametric

studies. In both cases performance of full journal bearings is shown to be both significantly improved by small offsets and fairly insensitive to small departures from optimal values.

and the elements of elastic deformations in the bearings are considered. The particular assembly used in this paper is based on a Wessex tail rotor gear box, although the program developed is of a general nature.

GEARS

84-853

Application of Fatigue Life Calculation to the Design and Selection of Gear Drives (Anwendung der Lebensdauerberechnung beim Entwurf und der Auswahl von Zahnradgetrieben)

G. Friedrich

VEB Kombinat Getriebe und Kupplungen Magdeburg, Hauptabteilung Erzeugnisentwicklung Dresden,
Maschinenbautechnik, 32 (10), pp 457-462 (1983) 17 figs, 5 refs
(In German)

Key Words: Gears, Fatigue life

Guidelines for the selection of gears are presented which combine fatiuge life calculations with service loads and dynamic bearing strength of the gears.

84-854

The Influence of Bearing Misalignment on the Performance of Helicopter Gear Boxes

M.M.A. Taha

College of Engrg., King Abdulaziz Univ., Jeddah, Saudi Arabia, Wear, 92 (1), pp 79-97 (1983) 10 figs, 4 tables, 5 refs

Key Words: Gear boxes, Helicopters, Bearings, Alignment

Misalignment in the bearings of a gear box affect the life of the bearings and the deflection of the tooth contact points of the gears and consequently, the performance of the gear box as a whole. Owing to the interaction of the deflections of all component parts of a gear box such as gears, shafts, bearings, spacers etc. it is necessary to consider these in combination rather than individually. A computer program was developed for analyzing typical helicopter gear boxes with cantilevered housings in which the gear shafts are supported by taper roller bearings. In this program such factors as the misalignment of the bearings, the torque transmitted, the bearing preload, the rigidity of the casing and shaft complete with the bearing spacer, the spacing between the bearings, the location of the external load

FASTENERS

84-855

Laminated Rubber Articulated Joint for the Deep Water Gravity Tower

F. Sedillot and A. Stevenson

C.G. Doris, Paris, France, J. Energy Resources Tech., Trans. ASME, 105 (4), pp 480-486 (Dec 1983) 11 figs, 7 refs

Key Words: Joints (junctions), Elastomers, Drilling platforms, Off-shore structures, Underwater structures

The Deep Water Gravity Tower is an articulated structure resting on a fixed base through an articulated joint which is composed of curved laminated rubber pads, made from alternate layers of rubber and metallic shims. The paper first outlines the main design concept with the articulated joint. Some analysis is then provided of the response to imposed rotation and vertical load. This includes a brief description of the results of a finite element analysis. The tests performed on laminated rubber during 1980 and 1981 to assess the feasibility of the articulation are reviewed.

STRUCTURAL COMPONENTS

CABLES

(Also see No. 1029)

84-856

Modeling of Submerged Cable Dynamics

J.W. Kamman and R.L. Huston

Dept. of Mech. and Indus. Engrg., Univ. of Cincinnati, OH, Rept. No. UC-MIE-070183-16-ONR, 35 pp (July 1, 1983)
AD-A132 495

Key Words: Underwater structures, Cables, Finite element technique

Results from a series of simulated submerged cable maneuvers are presented. The simulations are obtained using a three-dimensional, finite-segment model of the cable. The model, called UCIN-CABLE, consists of a series of pin connected rigid rods. Fluid drag, inertia, and buoyancy forces are included. Two types of simulation are presented: buoy release and anchor drop. The results compare favorably with experimental data and with data obtained from finite-element modeling.

BARS AND RODS

84-857

Emergence and Propagation of a Phase Boundary in an Elastic Bar

T.J. Pence

Div. of Engrg. and Applied Science, California Inst. of Tech., Pasadena, CA, Rept. No. TR-52, 127 pp (June 1983)

AD-A132 275

Key Words: Bars, Boundary value problems

This dissertation is concerned with the dynamical analysis of an elastic bar whose stress-strain relation is not monotonic. Sufficiently large applied loads then require the strain to jump from one ascending branch of the stress-strain curve to another such branch. For a special class of these materials, a nonlinear initial-boundary value problem in one-dimensional elasticity is considered for a semi-infinite bar whose end is subjected to either a monotonically increasing prescribed traction or a monotonically increasing prescribed displacement.

BEAMS

84-858

Dynamic Loading: More than Just a Dynamic Load Factor

W. Karthaus and J.W. Leussink

Prins Maurits Lab. TNO, Rijswijk, The Netherlands, The Interaction of Non-Nuclear Munitions with Structures: Symp. Proc., U.S. Air Force Academy, CO, May 10-13, 1983, Part 1, pp 151-154 (AD-A132 115)

AD-P001 733

Key Words: Beams, Blast response, Normal modes, Rotatory inertia effects, Transverse shear deformation effects

The response of a simply supported beam to uniform blast loading is determined by using the normal-mode technique. Especially for short load durations the higher modes become important. The rotary inertia and shear force deformation have to be taken into account. At short load durations high peaks of shear force appear near the supports immediately after loading.

84-859

Added Mass for Beam Mode Response

H.D. Fisher

Combustion Engineering, Inc., Windsor, CT 06095, J. Pressure Vessel Tech., Trans. ASME, 105 (4), pp 337-341 (Nov 1983) 3 figs, 3 refs

Key Words: Beams, Concentric structures, Coaxial structures, Added mass effects

In 1972 a method was presented for evaluating the added mass of fluid contained between two long co-axial cylinders. The resulting equations have been widely quoted in the literature, and the resistive forces obtained from these expressions have been utilized extensively in seismic and LOCA studies to demonstrate design integrity. The present study extends the analysis to less idealized design configurations in which a finite annular geometry is subjected to a velocity that is a function of the axial coordinate. The theory includes the capability to model the effect of any combination of closed-open axial boundary conditions on the fluid and to compute the added mass associated with motion of either or both of the radial boundaries.

84-860

Free and Forced Vibrations of Elastically Connected Double-Beam Systems

T.R. Hamada, H. Nakayama, and K. Hayashi

Dept. of Mech. Engrg., Sophia Univ., Kioi-Cho 7, Chiyoda-Ku, Tokyo, Japan, Bull. JSME, 26 (221), pp 1936-1942 (Nov 1983) 13 figs, 5 refs

Key Words: Beams, Free vibration, Forced vibration

The free vibrations and the forced vibrations of a system of two elastically connected parallel upper and lower beams having unequal masses and unequal flexural rigidities are analyzed by using a generalized method of finite integral transformation and the Laplace transformation. The natural

frequencies and the amplitude ratios for the normal modes of vibration are presented explicitly, and the effects of mass ratio and flexural rigidity ratio of the beams are discussed.

84-861

Vibration of Beams on Non-Homogeneous Elastic Foundations

M.N. Pavlovic and G.B. Wylie
Dept. of Civil Engrg., Imperial College of Science and Tech., London SW7 2AZ, UK, Earthquake Engrg. Struc. Dynam., 11 (6), pp 797-808 (Nov/Dec 1983) 5 figs, 13 refs

Key Words: Beams, Pile structures, Elastic foundations

The natural response of a beam or pile supported by an elastic foundation is investigated for the case when the coefficient of subgrade reaction varies linearly along the span of the member.

CYLINDERS

84-862

On Free Surface Oscillations of a Liquid Partially Filling a Rotating Cylinder (1st Report, Visualization of Resonant Mode and Analysis by Inviscid Theory)

S. Kaneko and S. Hayama
Univ. of Tokyo, Hongo Bunkyo-ku, Tokyo, Japan, Bull. JSME, 26 (221), pp 1985-1992 (Nov 1983) 10 figs, 4 refs

Key Words: Cylinders, Fluid-filled containers, Shafts, Sloshing

Free surface oscillations of a liquid partially filling a rotating cylinder which are called centrifugal waves are investigated both analytically and experimentally. In this report, general properties of centrifugal waves are analyzed under the assumption that the equilibrium state of the motion is a rigid-body rotation.

84-863

On Free Surface Oscillations of a Liquid Partially Filling a Rotating Cylinder (2nd Report, The Calculation of Fluid Force Using Boundary Layer Approximation)

S. Kaneko and S. Hayama
Univ. of Tokyo, Hongo Bunkyo-ku, Tokyo, Japan, Bull. JSME, 26 (221), pp 1993-2001 (Nov 1983) 12 figs, 4 refs

Key Words: Cylinders, Fluid-filled containers, Shafts, Sloshing

Free surface oscillations of a liquid partially filling a rotating cylinder are investigated analytically, taking the effect of viscosity near the wall into consideration. The fluid force acting on the rotating cylinder, when it is forced to move sinusoidally in the horizontal direction, is calculated by using boundary layer approximation.

COLUMNS

84-864

Dynamic Buckling of an Elastoplastic Column

G. Gary
Laboratoire de Mecanique des Solides, C.N.R.S., Ecole Polytechnique, 91128 Palaiseau, France, Intl. J. Impact Engrg., 1 (4), pp 357-375 (1983) 16 figs, 13 refs

Key Words: Columns, Dynamic buckling, Elastic plastic properties

Dynamic buckling of columns under axial step loading which produces plastic behavior is investigated. An experimental study is described and an elastoplastic model is developed in order to analyze the buckling process.

FRAMES AND ARCHES

84-865

Analysis of Buried Reinforced Concrete Arch Structures under Dynamic Loads

M.E. Auld and W.C. Dass
Applied Research Associates, Inc., Albuquerque, NM, The Interaction of Non-Nuclear Munitions with Structures: Symp. Proc., U.S. Air Force Academy, CO, May 10-13, 1983, Part 1, pp 119-123 (AD-A132 115)
AD-P001 727

Key Words: Arches, Reinforced concrete, Underground structures

A damped single degree-of-freedom model was developed to represent the gross dynamic behavior of shallow buried reinforced concrete arches subjected to specified nonuniform pressure distributions. Structural parameters were developed for a generic structure based upon available information in the literature and first principal calculations. Values of maximum crown deflection, calculated from numerical integration of the differential equation of motion, were compared with similar results from field experiments.

MEMBRANES, FILMS, AND WEBS

(See No. 869)

PLATES

84-866

Application of the Collocation Method to Vibration Analysis of Rectangular Mindlin Plates

T. Mikami and J. Yoshimura
Dept. of Civil Engrg., Hokkaido Univ., Sapporo, Japan, Computers Struc., 18 (3), pp 425-431 (1984) 4 figs, 5 tables, 15 refs

Key Words: Plates, Rectangular plates, Mindlin theory, Collocation method, Rotatory inertia effects, Transverse shear deformation effects, Variable cross section

The flexural vibration analysis of rectangular Mindlin plates using the collocation method is described. The results obtained by the present method are compared with published results for plates with uniform thickness and two opposite edges simply supported. The comparison shows that the method yields very good results with a relatively small number of collocation points, and that estimates for the higher modes can be obtained without any difficulties. The method is also applied to plates with linearly varying thickness, and new findings are presented for the frequencies of plates.

84-867

Non-Linear Dynamic Analysis of Orthotropic Annular Plates Resting on Elastic Foundations

Y. Nath and R.K. Jain
Dept. of Applied Mechanics, Indian Inst. of Tech., New Delhi 110016, India, Earthquake Engrg. Struc. Dynam., 11 (6), pp 785-796 (Nov/Dec 1983) 12 figs, 2 tables, 14 refs

Key Words: Plates, Annular plates, Elastic foundations, Nonlinear theories, Explosion effects, Orthotropism

The nonlinear dynamic behavior of orthotropic annular plates resting on Winkler and Pasternak elastic foundations are studied. Von Karman type nonlinear partial differential equations are solved using Chebyshev polynomials and implicit Houbolt numerical techniques in the space and time domains, respectively. Two different sets of boundary conditions are considered.

84-868

Vibration of Thermally Stressed Polar Orthotropic Annular Plates

D.G. Gorman
Dept. of Mech. Engrg., Queen Mary College, Univ. of London, London, UK, Earthquake Engrg. Struc. Dynam., 11 (6), pp 843-855 (Nov/Dec 1983) 4 figs, 4 tables, 29 refs

Key Words: Plates, Annular plates, Orthotropism, Flexural vibration, Temperature effects

The effect of uniform temperature on the natural frequencies of transverse vibration of uniform polar orthotropic annular plates is analyzed. The method employed is that of the annular finite element technique whereby the flexural and membrane components of the solution are separated. By close examination of the form of the resulting in-plane stress distribution due to the thermal loading, it is possible to obtain results for a wide selection of specimens by way of one equation and three graphs.

84-869

Low Frequency Acoustic Radiation and Vibration Response of Locally Excited Fluid-Loaded Structures

D.G. Crighton and D. Innes
Dept. of Applied Mathematical Studies, Univ. of Leeds, Leeds LS2 9JT, UK, J. Sound Vib., 91 (2), pp 293-314 (Nov 22, 1983) 2 figs, 32 refs

Key Words: Plates, Membranes (structural members), Fluid-induced excitation, Sound waves, Wave radiation

Low frequency heavy fluid loading effects on structures are studied, giving asymptotic solutions for a range of problems involving infinite, semi-infinite and finite thin elastic plates and membranes.

SHELLS

(Also see No. 1030)

84-870

Effects of Shear Deformation and Rotatory Inertia on Vibration and Buckling of Cylindrical Shells

K. Shirakawa
Dept. of Mech. Engrg., Univ. of Osaka Prefecture, Mozu-Umemachi, Sakai, Osaka 591, Japan, J. Sound Vib., 91 (3), pp 425-437 (Dec 8, 1983) 5 figs, 21 refs

Key Words: Shells, Cylindrical shells, Transverse shear deformation effects, Rotatory inertia effects, Vibration frequencies, Buckling

The vibration of cylindrical shells subjected to initial stresses is studied on the basis of a shell theory including shear deformation and rotatory inertia. The original equation system with five unknowns is reduced to one in three unknowns. An analysis is carried out for cylindrical shells with simply supported ends and the effects of initial stresses as well as shear deformation and rotatory inertia on the frequencies and the buckling forces are examined, and results are compared with those obtained by using classical thin shell theory.

84-871

Computerized Analysis of Shells – Governing Equations

D. Bushnell
Applied Mechanics Lab., Lockheed Palo Alto Res. Lab., 3251 Hanover St., Palo Alto, CA 94304, Computers Struc., 18 (3), pp 471-536 (1984) 55 figs, 9 tables, 81 refs

Key Words: Shells, Vibration analysis, Computer programs

A general discussion of terms in an energy functional which might be the basis from which equations governing stress, stability, and vibration analyses are derived is presented. The energy formulation for stress, stability, and vibration analyses of an elastic curved beam is given, including thermal effects, moderately large rotations, boundary conditions, and distributed and concentrated loads. A discussion on elastic shells of revolution includes a summary of what computer programs exist for stress, buckling, and stability analyses of such structures. Hybrid bodies of revolution are discussed and a summary of linear equations for general shells is presented.

84-872

Vibration of Submerged Hemi-Ellipsoidal Domes

C.T.F. Ross and T. Johns
Dept. of Mech. Engrg., Portsmouth Polytechnic, Portsmouth P01 3DJ, UK, J. Sound Vib., 91 (3), pp 363-373 (Dec 8, 1983) 12 figs, 4 tables, 9 refs

Key Words: Domes, Shells, Natural frequencies, Mode shapes, Submerged structures, Underwater structures

Ten thin-walled hemi-ellipsoidal domes were vibrated in air and also underwater. The domes varied in shape from oblate hemi-ellipsoids to prolate ones, and the fundamental eigenmodes were either axisymmetric or asymmetric, depending on the profiles of the domes. A varying meridional curvature annular element was developed for the shell and a similar one for the fluid, except that the latter was of quadrilateral cross-section. For submerged vibration, the two finite elements were coupled together and solution carried out through simultaneous iteration. Theoretical analyses with these structural and fluid finite elements gave satisfactory results compared to the experiments.

84-873

Nonlinear Analysis of Liquid-Filled Tank

Wing Kam Liu and D. Lam
Northwestern Univ., Tech. Inst., Evanston, IL 60201, ASCE J. Engrg. Mech., 109 (6), pp 1344-1357 (Dec 1983) 9 figs, 2 tables, 25 refs

Key Words: Tanks (containers), Fluid-filled containers, Nonlinear theories

Recent developments related to the analysis and design of liquid storage tanks are surveyed. Different aspects of the problem are examined. Background for finite element formulation is also outlined. A numerical tank model which accounts for the lateral pressure loading is developed to provide an understanding of this effect on the behavior of liquid storage tanks.

RINGS

84-874

Fracture Behavior of Brittle Circular Rings Subjected to Concentrated Impulsive Loading

S. Kida and J. Oda
Kanazawa Inst. of Tech., 7-1, Ogigaoka, Nonoichi-

machi, Ishikawa 921, Japan, Exptl. Mech., 23 (4), pp 425-430 (Dec 1983) 13 figs, 2 tables, 7 refs

Key Words: Rings, Fracture properties

The influence of impact velocity and ring geometry in the fracture patterns produced by in-plane concentrated impulsive loading on brittle circular rings has been studied both experimentally and theoretically.

84-875

Fragmentation of Metal Rings by Electromagnetic Loading

D.E. Grady and D.A. Benson

Sandia Natl. Labs., Albuquerque, NM 87185, Exptl. Mech., 23 (4), pp 393-400 (Dec 1983) 11 figs, 2 tables, 18 refs

Key Words: Rings, Fracture properties

A method is described for performing fragmentation studies on rapidly expanding metal rings. A fast-discharge capacitor system generates magnetic forces which accelerate the rings to maximum radial velocities of approximately 200 m/s corresponding to circumferential-strain rates of approximately 10^4/s at fragmentation.

PIPES AND TUBES

(Also see Nos. 953, 955, 1022)

84-876

On the Improvement of Ultrasonic Inspection Technology of ERW Pipe Seam

T. Okamura, K. Sakurai, S. Fukuda, and M. Kajiyama

Nippon Steel Corp., Hikari City, Yamaguchi Pref, Japan, NDT Intl., 16 (6), pp 331-338 (Dec 1983) 12 figs, 3 tables, 2 refs

Key Words: Pipes (tubes), Joints (junctions), Welded joints, Ultrasonic techniques, Crack detection

Ultrasonics is considered as a method for quality assurance of ERW pipeline. To improve the detectability of penetrators located within the pipe wall the basic reflection characteristics of various ultrasonic beam components from artificial reflectors is studied and a wide range of distance-amplitude curves is recorded. The relationship between the scanning conditions and the detectability of various natural imperfections is also investigated, and the optimum test conditions determined.

84-877

Discrimination of Ultrasonic Indications from Austenitic Stainless-Steel Pipe Welds

G.P. Singh and R.C. Manning

Southwest Res. Inst., 6220 Culebra Rd., San Antonio, TX 78284, NDT Intl., 16 (6), pp 325-330 (Dec 1983) 7 figs, 1 table, 7 refs

Key Words: Pipes (tubes), Welded joints, Ultrasonic techniques, Crack detection

The inspection of butt-welded stainless-steel pipe joints in nuclear power plants is routinely performed using ultrasonic non-destructive evaluation methods. Field experience, based on conventional ultrasonic signal-amplitude criteria, shows that a large number of indications are recorded. Most of these are not due to cracks, but are inherent in the geometry of the specimen. Discrimination between crack and geometric/weld indications is principally based on operator experience, variations in signal amplitude, and the location of the reflector. Significant differences in performance exist due mainly to operator experience, fatigue, concentration, and conventional signal-amplitude evaluation criteria. In response to this inspection problem, a pattern-recognition methodology has been developed to discriminate intergranular stress-corrosion cracking from geometric/weld reflectors in austenitic stainless-steel pipes. Results demonstrate that this algorithm can provide discrimination comparable to or better than those supplied by well trained operators.

84-878

Parametric Calculations of Fatigue-Crack Growth in Piping

F.A. Simonen and C.W. Goodrich

Battelle Pacific Northwest Labs., Richland, WA, Rept. No. PNL-SA-11134, CONF-830607-24, 15 pp (June 1983) (Pres. at the ASME Pressure Vessel and Piping Conf., Portland, OR, June 19, 1983) DE83013827

Key Words: Pipelines, Cracked media, Fatigue life

This study presents calculations of the growth of piping flaws produced by fatigue. Flow growth was predicted as a function of the initial flaw size, the level and number of stress cycles, the piping material, and environmental factors. The results indicate that the present flaw acceptance standards of ASME Section XI provide a relatively consistent set of allowable flaw sizes because the predicted life of flawed piping is relatively insensitive to pipe wall thickness, flaw aspect ratio, and piping material (ferritic versus austenitic).

84-879

Resonant Amplitudes of Pressure Pulsation in Pipelines (2nd Report, A Calculation by Method of Transfer Matrix)

Y. Mohri and S. Hayama

Univ. of Tokyo, Hongo, Bunkyo-ku, Tokyo, Japan, Bull. JSME, 26 (221), pp 1977-1984 (Nov 1983) 9 figs, 3 tables, 7 refs

Key Words: Pipelines, Resonant response, Transfer matrix method

A method is proposed to calculate the resonant amplitudes of pressure pulsation in pipelines by using transfer matrices in which equivalently linearized damping forces are employed. The resonant curves for several pipelines with an orifice, a tank or a branching are calculated. The results show good agreement with the experimental values.

84-880

Influence of Fluid Dynamic Parameters Upon Fluid-Hammer Forces and Spectra

G. Meder and J. Grams

Brown, Boveri & Cie AG, Kallstadter Strasse 1, 6800 Mannheim-Kafertal, Fed. Rep. Germany, Nucl. Engrg. Des., 77 (1), pp 7-21 (Jan 1984) 26 figs, 1 table, 9 refs

Key Words: Pipelines, Fluid hammer

For proper dynamic calculation of piping systems under fluid-hammer loading it is necessary to know the frequency content of the fluid-hammer forces. The spectra of fluid-hammer loading is examined; in particular, the influence of a change of fluid dynamic parameters upon the spectra is investigated.

84-881

Non Linear Analysis of Fluid-Structure Coupled Transients to Piping Systems Using Finite Elements. Application to the Mechanical Effects of the Sodium-Water Reaction in the Secondary Loop of a Pool Type LMFBR

F. Axisa and R.J. Gibert

CEA Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France, Rept. No. CEA-CONF-6363, CONF-820601-26, 21 pp (July 1982) (ASME Pressure Vessel and Piping Conf., Orlando, FL, June 27, 1982) DE83701758

Key Words: Piping systems, Nuclear reactors, Interaction: structure-fluid, Finite element technique

A finite element method based on a symmetric formulation which is aimed to compute the transient response of piping systems conveying compressible fluids is described. The method is able to treat both structural and fluid nonlinearities. Application is presented concerning the water-sodium reaction effects in a LMFBR secondary loop.

84-882

Leakage-Flow-Induced Vibration of a Tube-in-Tube Slip Joint (LMFBR)

T.M. Mulcahy

Argonne Natl. Lab., Argonne, IL, Rept. No. ANL-83-56, 17 pp (June 1983) DE83015748

Key Words: Tubes, Fluid-induced excitation, Joints (junctions)

The susceptibility of a cantilevered tube conveying water to self-excitation by leakage flow through a slip joint is assessed experimentally. The slip joint is formed by inserting a smaller, rigid tube into the free end of the cantilevered tube. Variations of the slip joint annular gaps and engagement lengths are tested, and several mechanisms for self-excitation are described.

84-883

Tube Vibration in a Half-Scale Sector Model of a Helical Tube Steam Generator

S.S. Chen, J.A. Jendrzejczyk, and M.W. Wambsganss

Argonne Natl. Lab., Argonne, IL 60439, J. Sound Vib., 91 (4), pp 539-569 (Dec 22, 1983) 8 tables, 15 refs

Key Words: Tubes, Tube arrays, Boilers, Testing techniques, Experimental data, Fluid-induced excitation

Experimental technique and results of tests on a half-scale sector model of a steam generator helical coil tube bank are presented. A series of tests was performed: bench tests of a single helical tube in air, tests of the sector model in air, tests of the sector model in stationary water to determine natural frequencies and damping, and tests in flow.

84-884
Seismic Damping Factors of Small-Bore Piping as Influenced by Insulation and Support Elements
L.K. Severud, M.J. Anderson, and D.A. Barta
Westinghouse Hanford Co., Richland, WA, Rept. No. HEDL-SA-2845-FP, CONF-830607-21, 25 pp (Jan 1983) (Pres. at the ASME Pressure Vessel and Piping Conf., Portland, OR, June 19, 1983)
DE83015475

Key Words: Pipelines, Nuclear reactors, Seismic design, Damping effects

Seismic damping tests of a prototypical liquid metal fast breeder reactor small-bore piping system is described and measured transient responses to pulse excitations are reported.

84-885
Dynamic-Stability Experiments in LMFBR Steam-Generator Tubes
D.M. France, R.D. Carlson, T. Chiang, and R. Roy
Argonne Natl. Lab., Argonne, IL, Rept. No. CONF-831047-74-Sum, 6 pp (1983) (Pres. at the Amer. Nuclear Soc. Winter Mtg., San Francisco, CA, Oct 30, 1983)
DE83015378

Key Words: Tubes, Boilers, Nuclear reactors, Stability, Experimental data

The purpose of this study was to experimentally determine the threshold of dynamic instability in sodium-heated boiling water tubes using a full scale LMFBR tube and prototypic system parameters. A series of 72 dynamic stability experiments were performed.

DUCTS

84-886
An Experimental Study of a Broadband Active Attenuator for Cancellation of Random Noise in Ducts
R.F. LaFontaine and I.C. Shepherd
Div. of Energy Tech., Commonwealth Scientific and Industrial Res. Organization, Melbourne, Australia, J. Sound Vib., 91 (3), pp 351-362 (Dec 8, 1983) 9 figs, 1 table, 15 refs

Key Words: Ducts, Noise reduction, Active attenuation, Wave attenuation, Sound waves

A broadband active attenuator for cancellation of plane wave duct noise has been demonstrated. Reductions of 16-20 dB RMS were achieved with random noise over the bandwidth 30-650 Hz, and 20 dB with transient noise. A two-microphone and two-loudspeaker unidirectional coupler arrangement was employed in the attenuator, with loudspeaker motional feedback, and a transversal filter which corrected residual amplitude and phase errors.

84-887
High Amplitude Acoustic Transmission through Duct Terminations: Theory
A. Cummings and W. Eversman
Univ. of Missouri-Rolla, Rolla, MO 65401, J. Sound Vib., 91 (4), pp 503-518 (Dec 22, 1983) 5 figs, 13 refs

Key Words: Sound transmission, Ducts

Recent experimental measurements have demonstrated that net acoustic energy dissipation can occur when sound waves interact with free shear layers, which are produced either by boundary layer separation in mean fluid flow at sharp edges, or by separation of the boundary layer in the acoustic flow at an edge in the absence of mean flow. This paper presents theoretical results which are offered in an attempt to explain these observations quantitatively.

84-888
Acoustic Power Dissipation on Radiation through Duct Terminations: Experiments
M. Salikuddin and K.K. Ahuja
Lockheed-Georgia Co., Marietta, GA 30063, J. Sound Vib., 91 (4), pp 479-502 (Dec 22, 1983) 22 figs, 23 refs

Key Words: Sound transmission, Ducts, Nozzles, Holes

This paper describes the acoustic transmission characteristics of ducts, nozzles, orifices, and perforated plates, studied under an experimental program using an acoustic impulse technique. In this technique high intensity pulses, generated by discharging a capacitor across a spark gap, were used as

the sound source. The test conditions include heated and unheated flows, with and without simulated flight. Results for a straight round duct, three convergent nozzles, a suppressor nozzle, 12 orifice plates, and 10 perforated plates are presented.

BUILDING COMPONENTS

(Also see No. 929)

84-889

A Scale Model Investigation of Sound Radiation from Building Elements

D.J. Oldham and Y. Shen

Dept. of Bldg. Science, Univ. of Sheffield, Sheffield S10 2TN, UK, J. Sound Vib., 91 (3), pp 331-350 (Dec 8, 1983) 8 figs, 3 tables, 8 refs

Key Words: Structural members, Sound waves, Wave radiation, Model testing

The directionality of sound radiated by typical building elements was investigated by using the techniques of acoustic scale modeling. The governing parameters of the model were first established and suitable modeling materials were then selected. The radiation patterns of a number of typical building elements were recorded and from a systematic examination of these patterns a predictive method suitable for implementation on a small computer was established.

84-890

The Prediction of Sound Fields Inside Non-Diffuse Spaces: Transmission Loss Considerations

E. Kruzins

Dept. of Architectural Science, Sydney Univ., Sydney, New South Wales 2006, Australia, J. Sound Vib., 91 (3), pp 439-445 (Dec 8, 1983) 4 figs, 1 table, 5 refs

Key Words: Sound transmission loss, Enclosures, Walls

The prediction of sound levels inside internally complex enclosures is extended to include transmission through walls. The sound field is estimated from the spatial variation of phonon density which is calculated by using a random walk technique. This statistical geometrical method also includes consideration of air attenuation and specular reflection of sound from walls whose individual random incidence absorption coefficients are individually known.

84-891

Probabilistic Procedures for Determining the Seismic Load Against Retaining Walls that Accounts for Strength Variability

D.A. Grivas and S. Slomski

Rensselaer Polytechnic Inst., Troy, NY, Rept. No. CE-82-B, NSF/CEE-82200, 169 pp (July 1982)
PB84-111467

Key Words: Retaining walls, Seismic excitation

Methods available for the determination of the force system acting on rigid retaining walls under static or seismic conditions are reviewed. The function of random soil parameters is described statistically. Two techniques capable of providing approximations to the statistical values of functions of random soil properties are investigated.

DYNAMIC ENVIRONMENT

ACOUSTIC EXCITATION

(Also see Nos. 832, 870, 887, 888, 889, 890, 970, 971)

84-892

Measurements of Machine Noise (Bullermaetningar pa Maskiner, Granuleringskvarnar och Falsmaskiner)

H. Jonasson

Statens Provningsanstalt, Boras, Sweden, Rept. No. SP-RAPP-1983:21, 72 pp (1983)
PB84-108786
(In Swedish and English)

Key Words: Machinery noise, Noise measurement

The West German standard DIN 46535 contains a description of the operating conditions during acoustical measurements of different machines. A Nordtest-project has, in Denmark, Finland, Norway and Sweden, investigated the possibilities of using these operating conditions when determining the sound power level and the sound pressure level at the operator's position. The result has become 2 proposals for Nordtest-methods, namely one for comminuting machines and one for sheet folding machines.

84-893

Computer-Aided Acoustic Power Determination (Rechnerunterstutzte Schalleistungsbestimmung)

M. Weck, P. Grund, and R. Humpert

Rechnerunterstützte Geräuschmesstechnik, VDI-Bericht, No. 468, pp 1-15 (1983) 21 figs, 12 refs

(In German)

Key Words: Sound power levels, Measurement techniques, Computer-aided techniques

Several computer-aided sound power measurement and evaluation techniques are described, and their advantages and disadvantages are discussed. Emphasis is placed on the evaluation of mean periodic error which in digital data pickup is caused by the scan frequency. In further sections the advantages provided by calculator in the determination of spacial effects, in the evaluation of data and in the documentation of measurement results are evaluated. Detailed information on noise sources is contained in the noise energy balance. The procedure is explained briefly and illustrated by an example. Two methods, the coherence and noise intensity method are detailed. These techniques are employed when the measurement of airborne sound is not feasible. The application of this method is possible only by means of calculators.

84-894

Sound Power from Sources Near Reverberation Chamber Boundaries

M.A.N. deAraújo and S.N. Yousri Gerges

Universidade Federal de Santa Catarina, Caixa Postal 476, Trindade -- CEP 88000, Florianópolis, SC, Brasil, J. Sound Vib., 91 (4), pp 471-477 (Dec 22, 1983) 6 figs, 11 refs

Key Words: Sound power levels, Measurement techniques

This paper is a theoretical and experimental attempt to quantify the effect of source positions near reverberation chamber boundaries on the measured source power. A correction factor is proposed which accounts for the effect of the chamber boundaries (floor, walls and ceiling).

84-895

Survey of Underwater-Acoustic Ray Tracing Techniques

R.M. Jones

Wave Propagation Lab., Natl. Oceanic and Atmospheric Admn., Boulder, CO, Rept. No. NOAA-TM-ERL-WPL-111, NOAA-83081103, 75 pp (June 1983)

PB83-250522

Key Words: Underwater sound, Computer programs

A survey of techniques and features available in underwater acoustic ray tracing computer programs is presented. The survey includes methods for constructing raypath trajectories, constructing eigenrays, ray-intensity calculations, and ray theory corrections. The survey also includes models for sound speed (including interpolation methods), ocean bottom (including both bathymetry and reflection coefficient), ocean surface reflection coefficient, dissipation, temperature, salinity, and ocean current. In addition, methods for displaying models and methods for presenting ray tracing results are surveyed.

84-896

Ray Theory versus the Parabolic Equation in a Long Range Ducted Environment

A. Tolstoy, E.R. Franchi, and K.R. Nicolas

Naval Res. Lab., Washington, DC, Rept. No. NRL-8730, SBI-AD-E000 544, 27 pp (Aug 22, 1983)

AD-A133 210

Key Words: Underwater sound, Sound transmission loss

An important type of underwater acoustic environment involves a deep water SOFAR channel with a superimposed (winter) surface duct capable of trapping acoustic energy. In this report the effects predicted by a computer model of three ducted sound speed profiles and two analytic profiles on acoustic propagation at 300 Hz are examined. The purpose of this study is to better understand the capabilities and limitations (both theoretical and numerical) of a ray theoretic model for predicting mid and long range signal transmission loss (TL) in the winter North Atlantic.

84-897

Discrete Section Synthesis of Acoustic Horns

P. Milenkovic

Univ. of Wisconsin, Madison, WI, J. Environ. Sci., 26 (6), pp 39-43 (Nov/Dec 1983) 10 figs, 5 refs

Key Words: Horns (sound generators), Acoustic tests, Testing techniques

An acoustic horn is used to couple an air-blast noise source to a reverberant test chamber. The Sabine approximation gives a value for the acoustic loading of the chamber. This loading condition is used to specify both forward and inverse transformations between horn geometry and horn frequency response. The inverse method is used to improve the frequency response near cutoff over what is achieved by a horn derived from rule-of-thumb formulas.

84-898

Fluid Dynamics of a Flow Excited Resonance, Part II: Flow Acoustic Interaction

P.A. Nelson, N.A. Halliwell, and P.E. Doak
Inst. of Sound and Vib. Res., Univ. of Southampton, Southampton S09 5NH, UK, J. Sound Vib., 91 (3), pp 375-402 (Dec 8, 1983) 15 figs, 11 refs

Key Words: Fluid-induced excitation, Resonant response, Acoustic resonance

This is the second of two companion papers in which the physics and detailed fluid dynamics of a flow excited resonance are examined. The approach is rather different from those previously used, in which stability theory has been applied to small wavelike disturbances in a linearly unstable shear layer, with an equivalent source driving the sound field which provides the feedback. In the approach used here, the physics of the flow acoustic interaction is explained in terms of the detailed momentum and energy exchanges occurring inside the fluid. Gross properties of the flow and resonance are described in terms of the parameters necessary to determine the behaviour of the feedback system. In this second paper it is shown that two relatively distinct momentum balances can be considered in the resonator neck region. One can be identified with the vortically induced pressure and velocity fluctuations and the other with the reciprocating potential flow.

84-899

High Frequency Green Function for Aerodynamic Noise in Moving Media, Part 1: General Theory

P.A. Durbin
NASA Lewis Res. Ctr., Cleveland, OH 44135, J. Sound Vib., 91 (4), pp 519-525 (Dec 22, 1983) 11 refs

Key Words: Aerodynamic noise, Turbulence, Green function

A method for constructing the high frequency Green function for a source in an arbitrary subsonic flow is described. This construction is done by matching a near source solution to a ray acoustics solution. The value of this Green function is that it can be used to calculate the noise produced by turbulent flows.

84-900

High Frequency Green Function for Aerodynamic Noise in Moving Media, Part II: Noise from a Spreading Jet

P.A. Durbin
NASA Lewis Res. Ctr., Cleveland, OH 44135, J. Sound Vib., 91 (4), pp 527-538 (Dec 22, 1983) 4 figs, 9 refs

Key Words: Aerodynamic noise, Turbulence, Green function

The high frequency Green function developed in Part I is used to calculate noise radiated from a quadrupole source, convected by a spreading jet. The effect of jet spreading is to eliminate the zone of silence, or at least, to replace it by a quieting zone. A comparison with experimental data shows that this effect of spreading can explain the penetration of sound into the zone of silence.

84-901

Introduction to the Parabolic Equation for Acoustic Propagation

A.B. Coppens
Naval Postgraduate School, Monterey, CA. Rept. No. NPS61-83-002, 45 pp (Nov 1982)
AD-A132 315

Key Words: Sound waves, Wave propagation, Wave equation

The derivation of the parabolic wave equation for acoustic propagation is studied and presented pedagogically for tutorial purposes. The literature is reviewed and modifications to the parabolic equation to increase accuracy are mentioned. Some of the algorithms for computer implementations of the parabolic approximation are discussed qualitatively, and the various approaches to dealing properly with the density change between the water column and the bottom are examined.

84-902

Calculation of the Sound Pressure Produced by Structural Vibration Using the Results of Vibration Analysis

J. Takatsubo, S. Ohno, and T. Suzuki
Government Industrial Res. Inst., Chugoku, Hiromachi, Kure-shi, Hiroshima-ken, Japan, Bull. JSME, 26 (221), pp 1970-1976 (Nov 1983) 10 figs, 1 table, 6 refs

Key Words: Vibrating structures, Vibration excitation, Sound waves, Wave generation

A method is presented to calculate the sound pressure produced by the structural vibration based on the results of the numerical or experimental vibration analysis of the structure. An application of the method to the prediction of the pressure of the sound radiated by an engine block model is presented.

84-903

Interference Effects in the Two Microphone Technique of Acoustic Intensity Measurements

G. Krishnappa

Natl. Res. Council of Canada, Ottawa, Ontario, Canada K1A OR6, Noise Control Engrg., 21 (3), pp 126-135 (Nov/Dec 1983) 23 figs, 9 refs

Key Words: Noise measurement, Acoustic intensity method, Two microphone technique

The interference effects in the two-microphone technique used to measure acoustic intensity are investigated. Experimental results indicate that for both the side-by-side and the face-to-face microphone arrangements, the interference effects are caused by the microphone supporting device being in close proximity to the measurement area. The interference effects can be almost eliminated by supporting the probes at large distances from the measurement points. The experimental studies also show that it is possible to make acoustic intensity measurements with good accuracy using either one of these two arrangements.

84-904

Cost-Effective Noise Abatement in Manufacturing Plants

E.I. Rivin

Wayne State Univ., Detroit, MI 48202, Noise Control Engrg., 21 (3), pp 103-117 (Nov/Dec 1983) 19 figs, 21 refs

Key Words: Noise reduction, Industrial facilities

A systematic approach to noise abatement in manufacturing plants is described. It is shown how the correct strategy, together with a thorough understanding of the structural dynamics of noise-generating devices and careful analysis of operational constraints, can achieve very substantial noise reductions with simultaneous improvement in performance and/or durability. Suitable techniques and recommendations are developed and largely implemented for a compressed air system, a material handling system (gravity action sliding and rolling chutes, vibration-stimulated chutes, containers, towed trailers, vibratory feeders), and production machinery.

84-905

Noise Control of Induction Furnaces

D.H. McQueen

AB Varilab; Master Bengtsgatan 10; 412 65 Gothenburg, Sweden, Noise Control Engrg., 21 (3), pp 118-125 (Nov/Dec 1983) 8 figs, 5 tables, 5 refs

Key Words: Noise reduction, Industrial facilities, Vibration measurement, Acoustic intensity method, Noise measurement

In steelworks and foundries an important source of noise is medium frequency induction furnaces for melting iron and steel scrap. The furnaces produce a tone at around 800 Hz; typical noise levels in the furnace area reach 80 to 90 dB. The noise situation is described, the generation mechanism is analyzed, and the vibration and intensity measurements are reported. Some noise reduction steps are introduced.

84-906

Analysis of Variability in Laboratory Airborne Sound Insulation Determinations

L. Taibo and H.G. De Dayan

Divisiόn Acύstica-Departamento de Fίsica, Instituto Nacional de Tecnologia Industrial, Buenos Aires, Argentina, J. Sound Vib., 91 (3), pp 319-329 (Dec 8, 1983) 3 tables, 9 refs

Key Words: Noise reduction, Measurement techniques

In an investigation of the overall precision of airborne sound insulation determinations in laboratory conditions 10 different samples were measured, according to the general procedure described in ISO 140/III, in a horizontal transmission chamber, with lateral flanking transmission. Measurements were carried out according to a prescribed program.

SHOCK EXCITATION

(Also see Nos. 794, 805, 965, 1027, 1031)

84-907

Impact Loading in Filamentary Structural Composites

R.L. Sierakowski and S.K. Chaturvedi

Dept. of Engrg. Sciences, Univ. of Florida, 231 Aerospace Engrg. Bldg., Gainesville, FL 32611, Shock Vib. Dig., 15 (10), pp 13-31 (Oct 1983) 7 tables, 12 refs

Key Words: Composite structures, Impact response, Reviews

This article summarizes work on the impact loading response of filamentary type composite materials. The following types of composites are included: boron-fiber, chopped-fiber, glass-fiber, graphite or carbon-fiber, hybrids, Kevlar-fiber with polymer matrix, and metal-matrix.

84-908

Limitations on the Applicability of High-Explosive Charges for Simulating Nuclear Airblast

D. Book, D. Fyfe, M. Picone, and M. Fry

Naval Res. Lab., Washington, DC, Rept. No. NRL-MR-5172, 38 pp (Sept 22, 1983)
AD-A133 368

Key Words: Simulation, Nuclear explosions

Since flow fields that result from nuclear and high explosive (HE) detonations are qualitatively alike but quantitatively different, care must be exercised in carrying over conclusions drawn from measurements of HE tests to nuclear explosions. The usefulness of HE explosions for simulating nuclear airblast is predicted on the fact that after reaching 5-6 times the initial radius, the flow field looks like that produced by a point source and produces shock overpressures similar to those in the nuclear case. Numerical simulations of airblast phenomena have been carried out using one- and two-fluid Flux-Corrected Transport hydrodycodes in one and two dimensions.

84-909

Blast Induced Soil Liquefaction - State-of-the-Art

W.A. Charlie, G.E. Veyera, S.R. Abt, and H.D. Patrone

Dept. of Civil Engrg., Colorado State Univ., Fort Collins, CO, The Interaction of Non-Nuclear Munitions with Structures: Symp. Proc., U.S. Air Force Academy, CO, May 10-13, 1983, Part 2, pp 62-68 (AD-A132 116)
AD-P001 758

Key Words: Soils, Explosion effects

This paper reviews blast induced soil liquefaction and describes an experimental laboratory testing program. The study of the behavior of water saturated sands under shock loadings is being conducted to evaluate potential blast induced changes in dynamic soil properties and soil shear strength loss (liquefaction). Of major interest is the behavior of the water pressure in the soil, both during and after the passage of the stress wave, as a function of strain, soil density, initial confining stress and the number of loadings.

84-910

Some Considerations in the Analysis and Prediction of Ground Shock from Buried Conventional Explosions

C.J. Higgins

Applied Res. Associates, Inc., Albuquerque, NM, The Interaction of Non-Nuclear Munitions with Structures: Symp. Proc., U.S. Air Force Academy, May 10-13, 1983, Part 2, pp 5-24 (AD-A132 116)
AD-P001 750

Key Words: Underground explosions, Ground shock

Several topics associated with the analysis and prediction of ground shock from buried conventional explosions are discussed. This paper addresses topics associated with general methodology and uncertainty.

84-911

Measurement of Blast-Induced Motion of Structures Using a Doppler Radar

R.K. Bailey, M. Brook, and J.J. Forster

Res. and Dev. Div., New Mexico Inst. of Mining and Tech., Socorro, NM, The Interaction of Non-Nuclear Munitions with Structures: Symp. Proc., U.S. Air Force Academy, CO, May 10-13, 1983, Part 2, pp 116-121 (AD-A132 116)
AD-P001 767

Key Words: Explosion effects, Structural response, Measurement techniques

Measuring the motion of structures in a blast environment by photographic means is often made difficult by the presence of optical obscurants such as dust, water spray, and detonation products (fireball). The use of a CW (continuous wave) Doppler radar to make measurements of the velocities of materials within these optically opaque environments offers potential advantages. Of particular interest is the possible utilization of low-cost intrusion alarm CW radars now being mass-produced for the house/industrial security market.

84-912

Response of Drag-Sensitive, Steel-Framed Industrial-Type Structures to Airblast Loading

H.S. Levine and E.M. Raney

Weidlinger Associates, Menlo Park, CA, The Interaction of Non-Nuclear Munitions with Structures: Symp. Proc., U.S. Air Force Academy, CO, May 10-13, 1983, Part 2, pp 103-109 (AD-A132 116)

AD-P001 765

Key Words: Explosion effects, Industrial facilities

Simple one-dimensional predictions of the response of drag-sensitive, steel-framed structures have greatly overestimated the peak deflections using the measured dynamic pressures, and commonly accepted drag coefficients for the beam, column and truss components. Renewed interest in the behavior of these structures has initiated recent efforts to explain the reasons for the discrepancies between analysis and experiment. The results of a series of three-dimensional calculations and the comparison of response with test data are reported.

84-913

Blast Response Tests of Reinforced Concrete Box Structures

D.R. Coltharp

Army Engineer Waterways Experiment Station, Vicksburg, MS, The Interaction of Non-Nuclear Munitions with Structures: Symp. Proc., U.S. Air Force Academy, CO, May 10-13, 1983, Part 2, pp 133-138 (AD-A132 116)

AD-P001 770

Key Words: Explosion effects, Blast response, Box type structures, Reinforced concrete

Six explosive tests were conducted against reinforced concrete walls to determine the effect of steel reinforcement design on structural response and damage. Reinforcement percentages varying from 0.25 to 2.0 and two reinforcement designs (one with shear stirrups and one with shear dowels) were tested.

84-914

Centrifugal Modeling Techniques

P.L. Rosengren

Air Force Engrg. and Services Ctr., Tyndall AFB, FL, The Interaction of Non-Nuclear Munitions with Structures: Symp. Proc., U.S. Air Force Academy, CO, May 10-13, 1983, Part 2, pp 25-28 (AD-A132 116)

AD-P001 751

Key Words: Explosion effects, Test facilities, Centrifugal forces

This research effort explored the feasibility of using a centrifuge as an experimental simulator to measure free-field blast parameters very near the explosive charge. A series of experimental blast events was conducted in the 30 g to 80 g range using a centrifuge test facility. The results of these tests concluded that the use of a centrifuge simulator is a workable concept for the determination of blast parameters.

84-915

Statistical Approach to Conventional Weapons Experimentation

J.M. Carson

New Mexico Engrg. Res. Inst., Albuquerque, NM, The Interaction of Non-Nuclear Munitions with Structures: Symp. Proc., U.S. Air Force Academy, CO, May 10-13, 1983, Part 2, pp 128-132 (AD-A132 116)

AD-P001 769

Key Words: Weapons effects, Testing techniques, Statistical analysis

A statistically based strategy of experimentation has been applied to the Air Force Weapons Laboratory's Conventional High Explosive Blast and Shock test series. The basis of this design and analysis method is reviewed. The purpose of the procedure is the measurement of the various experimental variances and the development of design curves that include confidence bands.

84-916

Behavior of Mounded Horizontal Cylinders in a Conventional-Weapon Environment

S.R. Whitehouse

Air Force Weapons Lab., Kirtland AFB, NM, The Interaction of Non-Nuclear Munitions with Structures: Symp. Proc., U.S. Air Force Academy, CO, May 10-13, 1983, Part 2, pp 148-155 (AD-A132 116)
AD-P001 773

Key Words: Cylinders, Explosion effects, Weapons effects

The behavior of a mounded horizontal cylinder exposed to conventional-weapon blast and shock effects is discussed. This discussion is based on data obtained in the horizontal cylinder test (HCT) series. This paper provides a summary of some of the HCT data, and examines the data to identify the important load and response mechanisms and possible failure modes for this configuration in a conventional-weapon environment.

84-917

Plain Concrete Loaded at High Strain Rates

R.G. Galloway

Air Force Weapons Lab., Kirtland AFB, NM, The Interaction of Non-Nuclear Munitions with Structures: Symp. Proc., U.S. Air Force Academy, CO, May 10-13, 1983, Part 2, pp 53-58 (AD-A132 116)
AD-P001 756

Key Words: Reinforced concrete, Explosion effects, Weapons effects, Nuclear explosion effects, Test facilities

Some information is available for strain rates from hydraulic testing machines and drop hammers. This report is to document the conclusions of the initial simplified calculations performed trying to define what information is known about strain rate sensitive behavior of concrete and how to set up an experimental program designed to answer pertinent questions. It was determined that the best constant strain rate loading device would consist of either a linearly increasing pressure load at the concrete specimen surface or a piston drive by a linearly increasing pressure.

84-918

High Explosive Testing of Hardened Aircraft Shelters

R.R. Bousek

Field Command, Defense Nuclear Agency, Kirtland AFB, NM, The Interaction of Non-Nuclear Munitions with Structures: Symp. Proc., U.S. Air Force Academy, CO, May 10-13, 1983, Part 2, pp 122-127 (AD-A132 116)
AD-P001 768

Key Words: Protective shelters, Aircraft, Hardened installations, Explosion effects, Experimental data

Two full-size, hardened, third-generation aircraft shelters were subjected to a series of five high explosive tests. The purpose of the tests was to gather empirical data necessary for the Department of Defense Explosives Safety Board to reduce existing explosives quantity-distance safety standards for storage of conventional munitions in and near hardened aircraft shelters.

84-919

Has a Decade Made a Difference

J.D. Haltiwanger

Univ. of Illinois at Urbana-Champaign, The Interaction of Non-Nuclear Munitions with Structures: Symp. Proc., U.S. Air Force Academy, CO, May 10-13, 1983, Part 2, pp 1-4 (AD-A132 116)
AD-P001 749

Key Words: Blast resistant structures, Nuclear weapons effects, Protective shelters

The design of structures to resist conventional weapons' effects is significantly more complex than is the design of structures to withstand the effects of nuclear weapons. In the case of nuclear weapons' effects, there are, really, only three problems that face the designer of a protective structure. These problems can be identified, in general terms, as follows: define the free-field, blast-induced environment in which the structure will exist; define the time-dependent and spatially distributed forces and motions that are imposed by this environment on the structure, and compute the response of the structure to these blast-imposed excitations.

84-920

Swedish Design Manual for Protective Structures

B.E. Vretblad and G.B. Svedbjoerk

Kungliga Fortifikationsfoevaltningen, Eskilstuna, Sweden, The Interaction of Non-Nuclear Munitions with Structures: Symp. Proc., U.S. Air Force Academy, CO, May 10-13, 1983, Part 1, pp 172-173 (AD-A132 115)
AD-P001 737

Key Words: Blast resistant structures, Protective shelters, Hardened installations, Manuals and handbooks

The design of Swedish military hardened concrete structures is based on different manuals, among those RSFA publ NBk 25. This publication gives design values for three different classes of structures A-C where different degrees of deformations are accepted. The paper describes the design procedures, according to the manual, with respect to fragment penetration.

84-921

Design of Underground Shelters Including Soil-Structure Interaction Effects

F.S. Wong and P. Wiedlinger

Weidlinger Associates, New York, NY, The Interaction of Non-Nuclear Munitions with Structures: Symp. Proc., U.S. Air Force Academy, CO, May 10-13, 1983, Part 1, pp 174-176 (AD-A132 115)

AD-P001 738

Key Words: Protective shelters, Underground structures, Interaction: *soil-structure, Design techniques*

Soil-structure interaction significantly affects the loads acting on buried shelters subjected to nearby explosions. Recent research has improved our understanding of this complex phenomenon and led to a new design method for buried shelters. This method recognizes the coupling between dynamic response of a buried structure and the loading exerted on it by the neighboring soil. It is simple to use, inexpensive and sufficiently accurate for most underground shelter designs.

84-922

Rational Approach to the Analysis of Structure

S.F. Borg

Dept. of Civil Engrg., Stevens Inst. of Tech., Hoboken, NJ, The Interaction of Non-Nuclear Munitions with Structures: Symp. Proc., U.S. Air Force Academy, CO, May 10-13, 1983, Part 1, pp 135-140 (AD-A132 115)

AD-P001 730

Key Words: Blast resistant structures, Blast response, Underground explosions

The two major data bases connected with underground blast effects on structures are utilized to obtain rational procedures for solving, approximately, the two fundamental engineering problems. The data bases are: accelerogram records at points in the field affected by the blast, and isoseismal contour maps for the entire field affected by the blast. These then lead to analytic expressions and charts for the engineering problems; namely, damage assessment and structural design/analysis.

84-923

AFWL CHEBS (Conventional High Explosive Blast and Shock) Test Series

D. Morrison

New Mexico Engrg. Res. Inst., Albuquerque, NM, The Interaction of Non-Nuclear Munitions with Structures: Symp. Proc., U.S. Air Force Academy, CO, May 10-13, 1983, Part 2, pp 145-147 (AD-A132 116)

AD-P001 772

Key Words: Explosion effects, Weapons effects, Protective shelters

The objective of the CHEBS test series is to develop a data base for the blast and shock environments created by conventional high explosive weapons and subsequently to develop appropriate analytical techniques. Both efforts are aimed at producing reliable protective structure design criteria. This paper presents results of this test series. In particular the free-field close-in blast and shock environment, bomb-to-bomb variation, and experimental error are examined. Brief results of a statistical analysis are presented.

84-924

Response of Reinforced Concrete Structures under Impulsive Loading

W.A. Millavec and J. Isenberg

Weidlinger Associates, Menlo Park, CA, The Interaction of Non-Nuclear Munitions with Structures: Symp. Proc., U.S. Air Force Academy, CO, May 10-13, 1983, Part 2, pp 88-93 (AD-A132 116)

AD-P001 762

Key Words: Protective shelters, Underground structures, Reinforced concrete, Ground shock, Explosion effects

A finite element method is presented to analyze the effects of airblast-induced ground shock on shallow-buried, flat-roofed, reinforced concrete structures. A finite element based on Timoshenko beam theory is adopted.

84-925

Review of the 1983 Revision of TM 5-855-1 'Fundamentals of Protective Design' (Nonnuclear)

S.A. Kiger and J.P. Balsara

Army Engineer Waterways Experiment Station, Vicksburg, MS, The Interaction of Non-Nuclear Munitions with Structures: Symp. Proc., U.S. Air Force Academy, CO, May 10-13, 1983, Part 2, pp 94-96 (AD-A132 116)

AD-P001 763

Key Words: Protective shelters, Manuals and handbooks

The purpose of this paper is to make potential users of the manual aware of the revision, aware of its scope, and indicate how and when it can be obtained. Because of space limitations only a few selected graphs from the manual will be presented as an indication of its content.

84-926

Analysis of Low Frequency Ground Motions Induced by Near-Surface and Atmospheric Explosions

J.R. Murphy, H.K. Shah, and T.K. Tzeng

S-Cubed, La Jolla, CA, Rept. No. SSS-R-82-5679, DNA-TR-81-157, SBI-AD-E301 207, 48 pp (Aug 1, 1982)

AD-A133 218

Key Words: Aerial explosions, Ground motion, Nuclear explosion effects

The results of a preliminary analysis of the effects of variations in height of burst (HOB) on the low frequency ground motions induced by near-surface and atmospheric explosions are described. A mathematical model which can be used to simulate this component of the explosively generated ground motions is described and applied to the parametric investigation of the effects of HOB on a prototype 1 kt nuclear explosion detonated over a site model approximating the subsurface geology at Yucca Flat on the Nevada Test Site.

84-927

Tests and Evaluations of Close-In Detonations

M.O. Kropatscheck

Federal Armed Forces Office for Studies and Exercises, Meppen, Fed. Rep. Germany, The Interaction of Non-Nuclear Munitions with Structures: Symp. Proc., U.S. Air Force Academy, CO, May 10-13, 1983, Part 1, pp 227-236 (AD-A132 115)

AD-P001 748

Key Words: Blast loads, Fracture properties

Some close-in detonation tests conducted in the FRG are described and methods to determine the loading caused by blast and fragmentation are mentioned. After establishing the load the local damage effects are explained theoretically. The problem of determining the blast load caused by cased cylindrical charges as well as the question of pressure waves caused by fragmentation is mentioned. Finally, the question of scaling fragmentation effects is considered.

84-928

Effects of Bare and Cased Explosives Charges on Reinforced Concrete Walls

H. Hader

Basler (Ernst) and Partners, Zurich, Switzerland, The Interaction of Non-Nuclear Munitions with Structures: Symp. Proc., U.S. Air Force Academy, CO, May 10-13, 1983, Part 1, pp 221-226 (AD-A132 115)

AD-P001 747

Key Words: Reinforced concrete, Explosion effects

This paper represents a summary of an extensive investigation concerning the local effects of bare and cased explosives charges on reinforced concrete walls. The investigation includes a literature search as well as several test series. As a main result, charts for the prediction and comparison of the effects of bare and cased explosives charges are developed.

84-929

Response of Structures to Detonations in Sand

B.E. Vretblad

Kungliga Fortifikationsfoevaltningen, Eskilstuna, Sweden, The Interaction of Non-Nuclear Munitions with Structures: Symp. Proc., U.S. Air Force Academy, CO, May 10-13, 1983, Part 1, pp 216-220 (AD-A132 115)

AD-P001 746

Key Words: Structural members, Walls, Underground explosions, Sand

Tests made at RSFA have shown how the pressure on the wall of a structure from detonations of explosives in sand

depends not only on the explosive and its distance to the wall but also on the properties of the wall (mass and stiffness). The paper gives data from these tests and a suggested procedure for design of walls in buried structures exposed to detonations effects. The procedure is based on an energy-absorption concept.

84-930
Response of a Linear Structure to an Exponential Pressure Pulse
F.D. Hains

Naval Surface Weapons Ctr., Silver Spring, MD, The Interaction of Non-Nuclear Munitions with Structures: Symp. Proc., U.S. Air Force Academy, CO, May 10-13, 1983, Part 1, pp 193-198 (AD-A132 115)
AD-P001 742

Key Words: Blast resistant structures, Blast response, Shock waves

Explosion dynamics is concerned with the response of structures to intense pressure loadings from shock waves. Most interactions that occur in practice are very complex, so that scaling laws are often employed to reduce the number of independent variables. Very often, this makes the results easier to interpret. Here, new similarity variables are introduced which lead to flatter response curves than those obtained previously. The energy transfer from the fluid to the structure is treated by computation of the fluid work done in the structure and the increase in elastic energy stored in the structure.

84-931
A Command Proceudre for Presenting the Parameters of the Shock Wave from Detonating Explosive Charges: Tryck
B. Tollbom

Foersvarets Forskningsanstalt, Stockholm, Sweden, Rept. No. FOA-C-20487-D4, ISSN-0347-3694, 18 pp (Mar 28, 1983)
N83-30980
(In Swedish)

Key Words: Shock waves, Aerial explosions

A computer operating system for an interactive determination of the independent variables of shock waves in the air is described. For a given distance and charge weight, one or several shock wave variables can be obtained. For a given charge weight the variables can be found for different distances. Variables can be determined by chart plotting. Data is available for trinito-toluene, and fuel-air explosive charges.

84-932
Seismic Design Response by an Alternative SRSS Rule
M.P. Singh and K.B. Mehta

Virginia Polytechnic Inst. and State Univ., Blacksburg, VA 24061, Earthquake Engrg. Struc. Dynam., 11 (6), pp 771-783 (Nov/Dec 1983) 6 figs, 2 tables, 24 refs

Key Words: Seismic design, Root mean squares

The square root of the sum of the squares (SRSS) procedure and its modified forms are often used to obtain seismic design response. The design inputs for such procedures are usually defined in terms of pseudo velocity or acceleration response spectra. Erroneous results have been obtained with these existing SRSS procedures, especially in the calculation of responses where high frequency effects dominate. An alternative SRSS procedure is developed using the so-called mode acceleration approach of structural dynamics. The design input in this procedure is defined in terms of relative acceleration and relative velocity spectra. The relative spectra can be related to pseudo spectra.

84-933
Shock and Seismic Response Spectra in Design Problems
Y. Matsuzaki and S. Kibe

Natl. Aerospace Lab., 1880 Jindaiji-Machi Chofu, Tokyo, Japan, Shock Vib. Dig., 15 (10), pp 3-10 (Oct 1983) 3 figs, 19 refs

Key Words: Shock response spectra, Seismic response spectra, Spacecraft, Seismic design, Reviews

This is a review of recent literature on shock and seismic response spectra techniques. Applications of shock response spectra in design problems are discussed. Descriptions of determinations of seismic response spectra from recorded ground motions are also given.

84-934

Hard Missile Impact on Reinforced Concrete

G. Hughes
Cement and Concrete Assn., Slough, SL3 6PL, UK,
Nucl. Engrg. Des., 77 (1), pp 23-35 (Jan 1984) 8 figs, 1 table, 10 refs

Key Words: Concretes, Reinforced concrete, Impact response, Penetration, Nuclear reactor containment

New penetration, scabbing and perforation formulae are derived for use in the design of reinforced concrete barriers to withstand impact by hard missiles. This is done by using dimensional analysis together with physical theories for the various impact processes.

84-935

A Computer-Based Simulation of Ice-Breaking by Impact

A. Mansour and A. Seireg
Univ. of Wisconsin-Madison, Madison, WI 53706,
J. Energy Resources Tech., Trans. ASME, 105 (4), pp 448-453 (Dec 1983) 10 figs, 1 table, 11 refs

Key Words: Ice, Fracture properties, Impact response, Icebreakers (ships), Computer programs

A computer simulation is developed for investigating ice-breaking by impulsive loading based on a specially developed finite element code. The computer program is capable of dealing with the multitude of complex conditions encountered in simulating ice-breaking.

84-936

Roughness-Induced Transient Loading at a Sliding Contact During Start-up

A. Anand and A. Soom
State Univ. of New York at Buffalo, ASME Paper No. 83-Lub-27

Key Words: Transient excitation, Surface roughness, Startup response

The effects of normal contact vibrations, horizontal rider dynamics, and surface texture inputs are combined to examine dynamic loads at a contact during acceleration from rest to a steady state velocity. A constant sliding friction coefficient is assumed.

VIBRATION EXCITATION

84-937

Finite Elements for the Dynamic Analysis of Fluid-Solid Systems

E.L. Wilson and M. Khalvati
Univ. of California, Berkeley, CA, Int.. J. Numer. Methods Engrg., 19 (11), pp 1657-1668 (Nov 1983) 6 figs, 2 tables, 14 refs

Key Words: Interaction: solid-fluid, Finite element technique

Several new finite elements are presented for the idealization of two- and three-dimensional coupled fluid-solid systems subjected to static and dynamic loading. The elements are based on a displacement formulation in terms of the displacement degrees-of-freedom at the nodes of the element. The formulation includes the effects of compressible wave propagation and surface sloshing motion.

84-938

Vibrations of a Forced Self-Excited System with Time Lag

Y. Yoshitake, J. Inoue, and A. Sueoka
Kyushu Univ., Hakozaki, Higashi-ku, Fukuoka-shi, Japan, Bull. JSME, 26 (221), pp 1943-1951 (Nov 1983) 17 figs, 2 tables, 11 refs

Key Words: Self-excited vibrations, Chatter, Machining

This paper deals with the forced self-excited vibration of a one-degree-of-freedom system with time lag in the nonlinear restoring force term. The resonance curve and stable zones of harmonic, 1/3-harmonic, and third higher harmonic vibration and beats developed from harmonic vibration are obtained. The effect upon these vibrations of the variation in time lag is investigated. The influence of initial conditions on the steady state solution is also examined by means of integral curves.

84-939

Cavitation in an Oscillatory Oil Squeeze Film

D.W. Parkins and R. May-Miller

Cranfield Inst. of Tech., UK, ASME Paper No. 83-Lub-30

Key Words: Cavitation, Oil film bearings

Observed features of cavitation arising in an oscillatory oil squeeze film are recorded. In the experimental apparatus, two nondeformable surfaces contained the oil film. The square upper surface oscillated, normally to the oil film, at any frequency between 5 and 50 Hz.

84-940

Interactions Among Friction, Wear and System Stiffness -- Part 1: Effect of Normal Load and System Stiffness

V. Aronov, A.F. D'Souza, S. Kalpakjian, and I. Shareef

Illinois Inst. of Tech., Chicago, IL, ASME Paper No. 83-Lub-34

Key Words: Stiffness effects, Friction, Wear, Vibration response, Experimental data

This paper describes the results of an experimental investigation of the effects of system stiffness on friction, wear and vibrations and their variations with normal load. Experiments were conducted using a pin-on-disk setup with a steel pin sliding on a cast iron disk without lubrication.

84-941

Interactions Among Friction, Wear, and System Stiffness -- Part 2: Vibrations Induced by Dry Friction

V. Aronov, A.F. D'Souza, S. Kalpakjian, and I. Shareef

Illinois Inst. of Tech., Chicago, IL, ASME Paper No. 83-Lub-35

Key Words: Friction, Vibration response

Different types of vibrations induced by dry friction are investigated by means of a model apparatus described in Part 1. The structural model is obtained from the measurement of the modal frequencies and damping ratios of three degrees of freedom. The oscillations in the normal and frictional forces, as well as the slider vibrations, have been measured and analyzed.

84-942

Interactions Among Friction, Wear, and System Stiffness -- Part 3: Wear Model

V. Aronov, A.F. D'Souza, S. Kalpakjian, and I. Shareef

Illinois Inst. of Tech., Chicago, IL, ASME Paper No. 83-Lub-36

Key Words: Stiffness effects, Wear, Fatigue life

It is shown that wear is an increasing function of system stiffness. The increase in the frequency of the applied load oscillations in normal dirction causes increase of number of loading cycles per unit time that, in turn, causes increased rate of wear particles formation due to fatigue. A wear model has been developed which accounts for slider oscillation in the normal direction.

84-943

Nodal Force Modelling in Random Continuous Loading

C. Georgiadis

Selskapet for Industriell og Teknisk Forskning, Norges Tekniske Hoegskole, Tronheim, Rept. No. STF-71A82010, 25 pp (June 1982)

DE83750840

Key Words: Floating structures, Wind-induced excitation, Random excitation

A method is presented for the computation of nodal forces in the case of narrow-banded surface continuous loading on a structure, when the load spatial correlation is an important factor. The method can be used for floating structures in a short-crested wave field or for structures under wind loading.

84-944

A Study of Displacement-Based Fluid Finite Elements for Calculating Frequencies of Fluid and Fluid-Structure Systems

L.G. Olson and K.-J. Bathe

Massachusetts Inst. of Tech., Cambridge, MA 02139, Nucl. Engrg. Des., 76 (2), pp 137-151 (Nov 1983) 20 figs, 5 tables, 30 refs

Key Words: Interaction: structure-fluid, Finite element technique, Natural frequencies, Fluids

The widely-used displacement-based finite element formulation for inviscid, compressible, small displacement fluid motions is examined, with the specific objective of calculating fluid-structure frequencies. It is shown that the formulation can be employed with confidence to predict the static response of fluids. Also the resonant frequencies of fluids in rigid cavities and the frequencies of fluids in flexible boundaries are solved successfully if a penalty on rotations is included in the formulation.

MECHANICAL PROPERTIES

DAMPING

(Also see No. 1019)

84-945

The Stability of Bi-Parametric Damped Oscillations

I. Misicu

Polytechnical Inst., Bucharest, Rev. Roumaine Sci. Tech., Mecanique Appl., 28 (3), pp 261-269 (May/June 1983) 10 figs, 12 refs

Key Words: Damping, Hill equation

An analysis of vibrations corresponding to the bi-parametric Hill equation is presented. The solutions are determined by means of trigonometric expansions. The neutral regions as well as the stability regions in the parametirc space are plotted into diagrams using special programming and computerized calculus. The damping effects are also investigated.

84-946

A Technical Note on Evaluation of Dampers

T.V. Gopalan

Central Power Res. Inst., P.O. Box 1242, Bangalore 560 012, India, Shock Vib. Dig., 15 (11), pp 3-4 (Nov 1983)

Key Words: Dampers, Reviews

The significance of the inverse standing wave ratio (ISWR) test and its role in assessing dampers and in obtaining other information needed for their evaluation are discussed in this technical note.

84-947

Stable Response of Damped Linear Systems

D.W. Nicholson and D.J. Inman

Naval Surface Weapons Ctr., White Oak, MD 20910, Shock Vib. Dig., 15 (11), pp 19-25 (Nov 1983) 49 refs

Key Words: Damped systems, Linear systems, Reviews

This paper updates and expands a previous review concerned with several aspects of the response of damped mechanical systems. Topics include asymptotic stability, oscillation conditions, forced response bounds, and eigenvalue localization. Considerable progress has been made on the last three topics but little on the first. Several simple new results are stated.

FATIGUE

(Also see No. 878, 942, 992)

84-948

Cumulative Plastic Deformation Observed During Cyclic Testing in Rolling Ball-Cylinder and Static Ball-Flat Plate Experiments

J.E. Morgan

Dept. of Mech. Engrg., Univ. of Bristol, Queen's Bldg., University Walk, Bristol BS8 1TR, UK, Wear, 92 (1), pp 25-30 (1983) 2 figs, 4 tables, 5 refs

Key Words: Fatigue life

The plastic deformation accompanying rolling contact and static ball-flat plate fatigue tests is described for identical experimental conditions. In particular, the problem of whether or not cumulative plastic deformation accompanies repeated Brinell indentations is investigated.

84-949

Study of Fatigue Durability of Advanced Composite Materials under Conditions of Accelerated Loading

H.M. Shih

Advanced Res. and Applications Corp., Sunnyvale, CA, Rept. No. NASA-CR-166405, 30 pp (Sept 1982) N83-31732

Key Words: Fatigue life, Composite materials, Temperature effects

The effect of temperature on the tension-tension fatigue life of the 2s T300/5208 graphite/epoxy angle-ply laminate system was investigated in an effort to develop an acceptable and reliable method of accelerated loading. Typical S-log10 N curves were determined experimentally at 25 C, 75 C, and 115 C. The time-temperature superposition principle was employed to find the shift factors of uniaxial fatigue strength and a general linear equation of S-log10 N for shifting purposes was established.

84-950

Probabilistic Fatigue Life Predictions of Structural Components in High-Cycle Fatigue Regimes

R.W. Lukens
Naval Postgraduate School, Monterey, CA, 144 pp (June 1983)
AD-A132 425

Key Words: Fatigue life, Prediction techniques, Computer programs

One method of predicting the probability of fatigue failure of a structural component is to determine the probability that the calculated cumulative fatigue damage index is greater than the critical damage index at failure. The cumulative fatigue damage is represented as a random variable, and the critical damage index is represented by the statistical variance of existing experimental data. A FORTRAN computer code using this failure criteria is presented, which calculates the probability of failure for a structural component in the high-cycle fatigue regime under a random stress response environment, using both the Weibull and log-normal statistical distribution models.

84-951

The Effect of Preload on Fatigue Strength of Residually Stressed Specimens

A.M. Nawwar and J. Shewchuk
Arctec Canada Limited, Kanata, Ontario K2K 1X3, Canada, Exptl. Mech., 23 (4), pp 409-413 (Dec 1983) 4 figs, 3 tables, 8 refs

Key Words: Fatigue life, Aluminum, Dimpling effects

This paper investigates the effect of preload on fatigue-strength improvements gained by compressive residual stresses induced mechanically by dimpling. Experiments on 2024-T3 aluminum-alloy specimens of two different types with preload ratios up to 1.2 and subsequent statistical analysis of data show that preload can be slightly beneficial or detrimental. The results are discussed with reference to residual-stress redistribution by preload.

84-952

Fatigue Damage-Strength Relationships in Composite Laminates. Volume 1

K.L. Reifsnider, W.W. Stinchcomb, E.G. Henneke, and J.C. Duke
Virginia Polytechnic Inst. and State Univ., Blacksburg, VA, Rept. No. AFWAL-TR-83-3084-VOL-1, 52 pp (Sept 1983)
AD-A133 485

Key Words: Fatigue life, Layered materials

This report is Vol. I of a 2-part final report. The general objective of this program was to investigate the precise nature of the damage events caused by cyclic (fatigue) loading of composite laminates that are directly related to fracture of those laminates, to develop a conceptual understanding of how those damage events reduce the residual strength of the laminates, and to determine how the collective damage condition following long-term cyclic loading precipitates the final fracture event.

84-953

A High-Strain Biaxial-Testing Rig for Thin-Walled Tubes under Axial Load and Pressure

D. Lefebvre, C. Chebl, L. Thibodeau, and E. Khazzari
Universite de Sherbrooke, Dept. of Civil Engrg., Sherbrooke, Quebec, Canada J1K 2R1, Exptl. Mech., 23 (4), pp 384-392 (Dec 1983) 9 figs, 19 refs

Key Words: Fatigue tests, Test equipment and instrumentation, Tubes

In this paper, an experimental testing rig capable of subjecting thin-walled tubes to combined dynamic loadings in tension-compression with torsion and tension-compression with internal-external pressure is presented. The following components are described: the mechanical and hydraulic system, servohydraulic control, specimen configuration, strain-measuring equipment and data-acquisition system. The computation of stresses and strains, as well as examples of data acquisition, are also shown.

84-954

Time Dependence of J-Integral

H.D. Schulze, H. Fuhlrott, and G. Togler
Rheinisch-Westfälischer Technisher Überwachungsverein e.V., Essen, Fed. Rep. Germany, Nucl. Engrg. Des., 76 (3), pp 375-379 (Dec 1983) 7 figs, 1 table, 9 refs

Key Words: Fatigue life, Fracture properties

Tests performed within the framework of earlier projects together with results obtained elsewhere with regard to the time dependence of fracture mechanics data show that time effects reduced the toughness of materials, according to the nature of the test (extremely slow load rate or hold times with sustained load).

84-955

Investigation of the Yield Behaviour of the Area Close to the Crack Tip for a Fine-Grained Structural Steel

H.G. Rumpf and O. Schadel
TÜV Bayern eV., München (Bavarian Technical Inspection Organization, Munich), Fed. Rep. Germany, Nucl. Engrg. Des., 76 (3), pp 365-373 (Dec 1983) 9 figs, 16 refs

Key Words: Pipes (tubes), Crack propagation

In the case of cracked structures with wall thicknesses such as are preferred in pipework construction, transition curves that are obtained by means of impact bending tests contribute to the improvement of knowledge on the notch-conditioned shift of the transition temperature and the modified conditions for cracks to start. The use of the grid etching technique provides possibilities of ascertaining the plastic deformation that takes place quantitatively at the start and during the course of cracking both in the near and distant fields.

84-956

Dynamic Fatigue of Brittle Materials Containing Indentation Line Flaws

B.L. Symonds, R.F. Cook, and B.R. Lawn
Natl. Bureau of Standards, Washington, DC, J. Materials Sci., 18, pp 1306-1314 (1983)
PB84-106145

Key Words: Fatigue life, Cracked media

A study is made of the dynamic fatigue response of brittle materials containing indentation-induced line flaws. The theoretical fracture mechanics of median crack evolution to failure under applied tension are first developed, with special emphasis on the role of residual contact stresses. In particular, it is shown that use of fatigue curves to evaluate the exponent in an assumed power-law crack velocity function may result in systematic error, by as much as a factor of two, if proper account is not taken of this residual contact contribution.

84-957

Theory of Fatigue for Brittle Flaws Originating from Residual Stress Concentrations

E.R. Fuller, Jr. and B.R. Lawn
Natl. Bureau of Standards, Washington, DC, J. Amer. Ceramic Soc., 66 (5), pp 314-321 (May 1983)

Key Words: Fatigue life, Cracked media

A theory is formulated for the general fatigue response of brittle flaws which experience residual stress concentrations. The indentation crack is taken as a model flaw system for the purpose of setting up the basic fracture mechanics equations, but the essential results are expected to have a wider range of applicability in the strength characterization of ceramics.

84-958

Fatigue Crack Initiation and Growth in HY 100 Steel Subject to In-Plane Biaxial Loading

E.W. Smith and K.J. Pascoe
Dept. of Engrg., Cambridge Univ., UK, Rept. No. CUED/C-MAT/TR-95, 102 pp (Sept 1982)
PB84-108018

Key Words: Fatigue life, Crack propagation, Steel

A brief review was carried out of the effects of stress biaxiality on initiation and cyclic stress/strain behavior. This included a detailed review of the literature on stress biaxiality and crack propagation. Fatigue initiation and crack propagation tests were carried out on HY 100 steel specimens.

84-959

Low-Cycle Fatigue Behavior of HT-9 Alloy in a Flowing-Lithium Environment

O.K. Chopra and D.L. Smith

Argonne Natl. Lab., Argonne, IL, Rept. No. CONF-830659-4, 8 pp (June 1983) (Pres. at the TMS/AIME Topical Conf. on Ferritic Alloys for Use in Nuclear Energy Technologies, Snowbird, UT, June 19, 1983)

DE83014819

Key Words: Fatigue life, Experimental data, Alloys

Low-cycle fatigue data have been obtained on normalized/tempered or lithium-preexposed HT-9 alloy at 755 K in flowing lithium of controlled purity. The results show that the fatigue life of this material decreases with an increase in nitrogen content in lithium.

84-960

Accelerated Compatibility Testing Using Corrosion Fatigue Techniques

R. Salzbrenner and J.A. Ruppen

Sandia Natl. Labs., Albuquerque, NM, Rept. No. SAND-83-1381C, CONF-8310111-1, 7 pp (1983) (DOE Annual Compatibility Mtg., Livermore, CA, Oct 18, 1983)

DE83015104

Key Words: Fatigue tests, Crack propagation

A corrosion fatigue test procedure based on fracture mechanics is a severe test of materials compatibility. Thus, fatigue-type tests can be used to demonstrate an accelerated cracking behavior. However, care must be taken when comparing fatigue crack growth behavior between two alloys and extrapolating to behavior under static loads.

84-961

Further Studies on Dynamic Crack Branching

M. Ramulu, A.S. Kobayashi, B.S.J. Kang, and D.B. Barker

Univ. of Washington, Seattle, WA, Exptl. Mech., 23 (4), pp 431-437 (Dec 1983) 11 figs, 1 table, 17 refs

Key Words: Crack propagation

The newly derived dynamic-crack-branching criterion with its modifications is verified by the dynamic-photoelastic results of dynamic crack branchings in thin-polycarbonate, single-edged crack-tension specimens.

84-962

On the Determination of Fracture-Mechanics Data Using the Nearfield at the Tip of Dynamically Loaded Cracks

C. Zimmermann

MPA Stuttgart, 7000 Stuttgart 80, Fed. Rep. Germany, Nucl. Engrg. Des., 76 (3), pp 359-363 (Dec 1983) 4 figs, 12 refs

Key Words: Fracture properties, Crack propagation

This paper discusses some common methods of data evaluation in dynamic fracture mechanics. This is done in regard to the restriction arising from the available testing-machines as well as due to the dynamic effects in the specimen which control the crack initiation process. It is concluded that only the process at the crack tip itself determines the dynamic crack initiation at very high K-values and consequently only data from the crack tip's nearfield will yield a correct interpretation of the events in the specimen.

WAVE PROPAGATION

(Also see No. 931)

84-963

Eigenvalues of Slender Cavities and Waves in Slender Tubes

J.F. Geer and J.B. Keller

Thomas J. Watson School of Engrg., Applied Sciences and Tech., SUNY, Binghamton, NY 13901, J. Acoust. Soc. Amer., 74 (6), pp 1895-1904 (Dec 1983) 2 figs, 2 tables, 7 refs

Key Words: Wave propagation, Cavities, Tubes

An asymptotic method is used to find the eigenvalues and eigenfunctions of the reduced wave equation in slender cavities, and to find the modes of propagation in slender tubes. The results for the eigenvalues of prolate spheroids are found to be in good agreement with those computed numerically by Chang.

84-964

Propagation of Long Waves into a Set of Parallel Vertical Barriers on a Rotating Earth

G.M. Kapoulitsas

Higher Technical Education Centre (K.A.T.E.), Thessaloniki, Greece, Wave Motion, 6 (1), pp 1-14 (Jan 1984) 1 fig, 10 refs

Key Words: Wave propagation

The problem of propagation of long waves into a set of parallel vertical barriers on a rotating system is considered and an exact solution is obtained showing that an appropriate Kelvin wave is created in all parts of the field.

84-965

Weak Shock Diffraction

J.K. Hunter and J.B. Keller

Dept. of Mathematics, Colorado State Univ., Fort Collins, CO 80523, Wave Motion, 6 (1), pp 79-89 (Jan 1984) 4 figs, 13 refs

Key Words: Shock waves, Wave diffraction

The diffraction of a weak shock by a rigid wedge is analyzed theoretically via the theory of weakly nonlinear geometrical acoustics, which is the same as Whitham's nonlinearization technique. Linear weakly nonlinear geometrical acoustics is explained and the linear acoustics results for weak shock diffraction by a wedge are presented. These results are modified according to the principles of weakly nonlinear geometrical acoustics.

84-966

High-Frequency Scattering of Elastic Waves from Cylindrical Cavities

R.J. Brind, J.D. Achenbach, and J.E. Gubernatis

Technological Inst., Northwestern Univ., Evanston, IL, 60201, Wave Motion, 6 (1), pp 41-60 (Jan 1984) 8 figs, 1 table, 21 refs

Key Words: Elastic waves, Wave scattering, Cylindrical cavities

The scattering of time-harmonic plane longitudinal elastic waves by smooth convex cylindrical cavities is investigated. The exact solution for a circle is evaluated for wavelengths of the same order as the radius, and the geometrical and physical elastodynamics approximations are shown to be inadequate. The application of Watson's transformation exhibits the various diffraction effects and the relative importance of each is assessed.

84-967

SEM Approach to the Transient Scattering by an Inhomogeneous, Lossy Dielectric Slab; Part 1: The Homogeneous Case

A.G. Tijhuis and H. Blok

Lab. of Electromagnetic Res., Dept. of Electrical Engrg., Delft Univ. of Tech., 2600 GA Delft, The Netherlands, Wave Motion, 6 (1), pp 61-78 (Jan 1984) 9 figs, 6 tables, 15 refs

Key Words: Elastic waves, Wave scattering

In two companion papers, the singularity expansion method is applied to the computation of the transient scattering of a pulsed electromagnetic wave of finite duration by an isotropic, inhomogeneous, lossy dielectric slab. The time-domain electric field is expressed as a Laplace inversion integral over the Bromwich contour. Conditions for the validity of a representation in terms of natural-mode quantities only are derived; i.e., for a vanishing integral along the closing contour in the left halfplane, the latter being the contribution from the essential singularity at infinity. In the present paper, this procedure is first carried out for a homogeneous slab. For that case, an alternative method exists where the computation of the integral along the closing contour is reduced to a modification of the residual contributions from the poles and the numerical evaluation of a principal-value integral along the branch cut of the complex index of refraction.

84-968

Finite Element-Boundary Integral Formulation for Electromagnetic Scattering

M.A. Morgan, C.H. Chen, S.C. Hill, and P.W. Barber

Dept. of Electrical Engrg., Naval Postgraduate School, Monterey, CA 93940, Wave Motion, 6 (1), pp 91-103 (Jan 1984) 9 figs, 1 table, 17 refs

Key Words: Electromagnetic waves, Wave scattering

A new formulation is described which combines the most robust attributes of the volume finite element and surface integral equation approaches to electromagnetic boundary value solutions. The result is a numerical technique which may be applied to scattering problems involving configurations having metallic surfaces and inhomogeneous penetrable material situated in open spatial regions.

84-969
A Comparison of the Dynamic Response of the ACS and SLS Models for Linear Viscoelasticity
M.J. Pound, R.C.Y. Chin, and G.W. Hedstrom
Lawrence Livermore Natl. Lab., Univ. of California, Livermore, CA 94550, Wave Motion, 6 (1), pp 23-32 (Jan 1984) 3 figs, 5 refs

Key Words: Wave propagation, Viscoelastic media

Using asymptotic analysis and numerical computation, the behavior of the three-parameter viscoelastic model proposed by Achenbach and Chao (ACS) is compared with that of the standard linear solid (SLS) in one-dimensional wave propagation. The models behave very similarly in both the near and far fields and the much simpler form of the fundamental solution for the Achenbach-Chao model may make it preferable in many applications.

84-970
Viscous Effect on Acoustic Scattering by Elastic Solid Cylinders and Spheres
W.H. Lin and A.C. Raptis
Argonne Natl. Lab., Argonne, IL, Rept. No. ANL/FE-83-5, 52 pp (Apr 1983)
DE83014271

Key Words: Sound waves, Wave scattering, Cylinders, Spheres

This paper deals with analytic studies and numerical results of the scattering of plane sound waves from an elastic circular cylinder and from an elastic sphere in a viscous fluid. The elastic properties of the cylinder and the sphere and the viscosity of the surrounding fluid are taken into account in the solution of the acoustic-scattering problems.

84-971
Turn-Around Loss for Oceanic Sound on a Bottom Slope
D.E. Weston
Admiralty Underwater Weapons Establishment, Portland, UK, Rept. No. AUWE-TN-705/83, DRIC-BR-88862, 15 pp (Apr 1983)
AD-A132 010

Key Words: Underwater sound, Sound waves, Wave reflection

For oceanic sound reflected from a region of bottom slope the turn-around loss equals the sum of the bottom losses, and can be quite low if the total deflection in horizontal angle is low. Simple formulae are derived, and the effects of the slope being finite are discussed.

EXPERIMENTATION

MEASUREMENT AND ANALYSIS

(Also see Nos. 903, 905)

84-972
Analysis of Vibration by Substructure Synthesis Method (Part 2: Development of Optimum Design System I)
A. Nagamatsu, T. Iwamoto, and Y. Fujita
Tokyo Inst. of Tech., 12-1, Ohokayama 2-chome, Meguro-ku, Tokyo, Japan, Bull. JSME, 26 (221), pp 1958-1969 (Nov 1983) 9 figs, 9 tables, 4 refs

Key Words: Modal analysis, Substructuring methods, Optimum design

Two analytical methods are introduced by which changes of the natural frequencies, the natural modes and the dynamic response due to alteration of the local physical properties (i.e., mass, stiffness, damping, shell thickness etc.) of a structure can be predicted easily, using the modal parameters of this structure before alteration. A computer program by one of these methods is made for practical use.

84-973
Combination of Multiple Input Models and Experimental Modal Analysis for Identification of Structural Noise Generating Mechanisms: With Application to Forge Hammers
M.W. Trethewey, H.A. Evensen, and W.R. Shapton
Pennsylvania State Univ., University Park, PA 16802, Noise Control Engrg., 21 (3), pp 89-102 (Nov/Dec 1983) 13 figs, 22 refs

Key Words: Modal analysis, Noise source identification, Forging machinery

A procedure is presented which combines multiple-input modeling techniques and experimental modal analysis to develop control strategies for structurally generated noise. Multiple input models are used to rank the noise contributions from individual coherent structural members. From this ranking, frequencies associated with important sound radiating modes can be distinguished from inefficient modes.

84-974

Time Series Long Memory Identification and Quantile Spectral Analysis

E. Parzen

Dept. of Statistics, Texas A&M Univ., College Station, TX, Rept. No. TR-A-23, 37 pp (Aug 1983) AD-A132 240

Key Words: Spectrum analysis

An approach to spectral estimation is described which involves the simultaneous use of frequency, time, and quantile domain algorithms, and is called quantile spectral analysis. It is based on the premise that while the spectrum is a nonparametric concept, its estimation cannot be a non-parametric procedure to be conducted independently of model identification.

84-975

Computer-Aided Acoustic Measuring Systems (Rechnergesteuerte akustische Messsysteme)

R. Thees

Rechnerunterstützte Gerätetechnik, VDI-Berichte, No. 468, pp 67-69 (1983) 2 figs, 1 table, 1 ref

(In German)

Key Words: Acoustic measuring instruments, Measuring instruments, Computer-aided techniques

A computer-aided acoustic measurement system is described which includes the integrating noise level analyzer RC 325, a fast correlation measurement system (30 Hz), and a real time frequency analyzer, SA 25.

84-976

Experience with a Special Computer-Aided Measuring System for the Measurement of Interior and Outside Noise of Automobiles

P. Seifert

Rechnerunterstützte Gerätemesstechnik, VDI-Berichte, No. 468, pp 41-45 (1983) 6 figs, 5 refs

(In German)

Key Words: Measuring instruments, Noise measurement, Ground vehicles

A system, called the Acoustic Computer Real Time Analyzer (ACORA), intended for noise measurement of ground vehicles, is investigated. Its main components are the desktop calculator with an extensive special purpose software for signal analysis, and a terzanalyzer to which the measurement results are transmitted either directly or by means of a magnetic tape. Immediately after input, the results are plotted by the plotter directly on the computer screen. Other tasks, such as preparation of velocity signals and the storage and archiving of data, are performed by the remaining components.

84-977

A Demonstration of a Special Computer-Aided Measuring System for Automobiles (Vorstellung eines speziellen rechnergesteuerten Messsystems für Kraftfahrzeuge)

M. Schulthes

Rechnerunterstützte Gerätemesstechnik, VDI-Berichte, No. 468, pp 37-40 (1983) 4 figs

(In German)

Key Words: Real time spectrum analyzers, Spectrum analyzers, Computer-aided techniques, Measuring instruments, Noise measurement, Automobiles

ACORA (acoustic computer real time analyzer) is a desk top measurement and analysis system for acoustic measurements of motor vehicles and other machinery during fast changing operating conditions. It combines extremely high speed of data acquisition and a high flexibility of evaluation. In addition, the system is mobile and easy to service, even without any experience with desk calculators.

84-978

Vehicle Noise Measurement and Evaluation by Means of Computer-Aided Techniques (Geräuschmessung und -auswertung mit Rechnerunterstutzung an Strassenfahrzeugen)

D. Karstens

Wolfsburg, W. Germany, Rechnerunterstützte Gerätemesstechnik, VDI-Berichte, No. 468, pp 29-36 (1983) 12 figs, 7 refs
(In German)

Key Words: Noise measurement, Measurement techniques, Ground vehicles, Computer-aided techniques

Several recent computer-aided techniques for measuring structure-borne and airborne noise, as well as vibrations, of automobiles are presented. Three methods described are: measurement of flexural vibration modes by means of a process calculator (processrechner), acoustic intensity measurement by means of a "processrechner," and "TIPUED" for real time determination of Terz-Octave specta with storage in large computer.

84-979

The Influence of Shear Modulus and Damping Ratio on Amplification Spectrum and Response Spectra

G. Mărmureanu, D. Bratosin, F.S. Bălan, and E. Cojocaru

Ctr. of Earth Physics and Seismology, Bucharest, Romania, Rev. Roumaine Sci. Tech., Mecanique Appl., 28 (2), pp 175-184 (May/Apr 1983) 6 figs, 5 tables, 4 refs

Key Words: Response spectra, Shear modulus, Damping effects, Resonance bar techniques

The paper summarizes the results obtained regarding the influence of shear modulus and damping ratio on site amplification spectrum and response spectra. There is a strong nonlinear dependence of shear modulus and damping ratio with dynamic shear strain.

84-980

Ultrasonic Transducer of Polyvinyldifluoride with Broadband Transmission and Focussing Properties (Ultraschallwandler aus Polyvinylidendifluorid mit breitbandigem Übertragungsverhalten und fokussierenden Eigenschaften)

M. Platte

Institut f. Technische Akustik der Rheinisch-Westfälischen Technischen Hochschule, Aachen, W. Germany, Acustica, 54 (1), pp 23-32 (Nov 1983), 16 figs, 1 table, 18 refs
(In German)

Key Words: Measuring instruments, Ultrasonic techniques

An ultrasonic transducer with plane and curved piezoelectric films and layers of polyvinyldifluoride is described. Transducers with a piezoelectrically active layer having broadband frequency transmission characteristics and multilayer transducers for the generation and reception of Barker-coded signals are produced by means of plane radiating surfaces. Line and point focusing is achieved by cylindrical, conical, and spherical bending of the stretched films. A miniature hydrophone is produced by covering a metal spike with a piezoelectric polyvinyldifluoride film. Construction of the transducer and measurement methods are given.

84-981

Computer-Controlled System for Nondestructive Thickness Measuement of Corroded Steel Structures

A. Singh and R. McClintock

Southwest Res. Inst., San Antonio, TX 78284, J. Energy Resources Tech., Trans. ASME, 105 (4), pp 499-502 (Dec 1983) 7 figs, 1 table, 4 refs

Key Words: Acoustic measuring instruments, Measuring instruments, Computer-aided techniques, Corrosion, Underwater structures, Off-shore structures

Over a period of time, corrosion attacks the surface of offshore and waterfront steel structures and can cause catastrophic failures. To date, thickness measurement to determine loss from corrosion has been performed visually; however, this method provides only limited assessment. A computer-controlled ultrasonic system to more accurately measure corroded steel structure thickness is described. The system is based on an innovative concept using an ultrasonic focused transducer aligned directly over the center of corrosion pits.

84-982

A Highly Sensitive Noncontacting Electromagnetic Device for Detecting Dynamic Stress in Structures

G.N. Reddy and S. Saha

Michigan Technological Univ., Houghton, MI 49931, Exptl. Mech., 23 (4), pp 418-424 (Dec 1983) 7 figs, 2 tables, 10 refs

Key Words: Proximity probes, Electromagnetic properties, Piezoelectric gages, Stress waves

A highly sensitive, noncontacting electromagnetic device has been developed to detect stress waves in structures. It is shown that for detecting an induced strain this device is over 500 times more sensitive than conventional bonded strain gages.

84-983

Dynamic Heterogeneous Response of Aluminum and Copper to Stress Waves

F.C. Perry

Sandia Natl. Labs., Albuquerque, NM, Rept. No. SAND-83-1432C, CONF-830719-15, 4 pp (1983) (Pres. at the Amer. Physical Soc. Mtg. on Shock Waves in Condensed Media, Santa Fe, NM, July 18, 1983)
DE83015229

Key Words: Holographic techniques, Interferometric techniques, Dynamic response, Aluminum, Copper

Holographic interferometry is used to measure the time- and space-resolved dynamic response of materials to stress waves. Factors such as material strength, viscosity, and wave interactions that may influence heterogeneous response are discussed.

84-984

Proximity Sensors. 1975 - October, 1983 (Citations from the International Information Service for the Physics and Engineering Communities Data Base)

NTIS, Springfield, VA, 119 pp (Oct 1983)
PB84-851369

Key Words: Proximity probes, Measuring instruments, Bibliographies

This bibliography contains 158 citations concerning the various types of proximity sensors. Optical, electric, magnetic, ultrasonic, and air-jet are included, and their fields of application in industry are discussed.

84-985

Sensor Technology -- a New Discipline? (Sensortechnik -- eine neue Disziplin?)

K. Gunzel

Siemens AG, Bereich Systemtechnische Entwicklung-Messsysteme, Sensorik, Östliche Rheinbrückenstrasse 50, D-7500 Karlsruhe 21, Germany, Techn. Messen-TM, 50 (10), pp 355-358 (1983) 4 figs, 5 refs
(In German)

Key Words: Measuring instruments, Detectors

At the present time the term "sensor" is used with various connotations. It ranges from plain transducers to devices for scene recognition with digital signal processing and the required software. This paper describes the field of sensor technology. A distinction between basic sensor and sensor-system is proposed.

84-986

Rugged Heavy Duty Linear Displacement Transducers (Robuste Wegsensoren für extreme Belastungen)

D. Krause and K.O. Lehmann

Techn. Messen-TM, 50 (10), pp 373-379 (1983) 10 figs, 29 refs
(In German)

Key Words: Measuring instruments, Proximity probes, Displacement transducers

A sensor is described for length measurement applications in process technology. Its principle is based on a type of convertible transformer in which the coupling between primary and secondary windings is changed. This coupling is achieved by the contactless deviation of a circular shunt situated on the long arms of a soft-magnetic slitless window. A separate electronic system converts the deviation into a normalized analogue output signal. The sensor is designed for applications under extreme environmental conditions (high temperature, high levels of acceleration, aggressive substances) and can be separated from the electronics by a distance of up to 50 m.

84-987

An Acoustic System for Pipeline Profile Measurement

H. Van Calcar

Honeywell, Inc., Seattle, WA 98107, J. Energy Resources Tech., Trans. ASME, 105 (4), pp 475-479 (Dec 1983) 9 figs

Key Words: Acoustic measuring instruments, Measuring instruments, Sound transmission, Pipelines, Underwater pipelines, Underwater structures

An acoustic position measurement system used for precise three-dimensional flowline profile measurement is presented. The system measures several points along the flowline using the long-baseline measurement technique and augments this measurement with depth telemetry repeaters to maintain elevation accuracy throughout the changing installation geometry. The paper discusses both the measurement system and the performance enhancement features.

84-988

Signal Transmission in Ultrasonic Fluid-Flow Measurement by Means of Transit Time Difference Procedure (Signalubertragung bei der Durchflussmessung mit Ultraschall nach dem Laufzeitdifferenzverfahren)

H. Lechner

LGZ Landis & Gyr Zug AG, CH-6301 Zug, Switzerland, Acustica, 54 (1), pp 33-38 (Nov 1983) 7 figs, 7 refs

(In German)

Key Words: Measuring instruments, Ultrasonic techniques

The transmission characteristic of a measurement segment during the ultrasonic fluid-flow measurement by means of Transit Time Difference procedure is calculated using the measurements of a single ultrasonic transducer. These transducers are axially polarized piezoceramics having a single resonance and bell-shaped waveform.

DYNAMIC TESTS

(Also see Nos. 914, 917)

84-989

UK Developments in Structural Integrity Aspects of NDT

A. Rogerson and P.J. Highmore

Risley Nuclear Power Development Labs., United Kingdom Atomic Energy Authority (Northern Div.), Risley, Warrington WA3 6AT, UK, Nucl. Engrg. Des., 76 (3), pp 261-273 (Dec 1983) 11 figs, 27 refs

Key Words: Nondestructive tests, Ultrasonic techniques, Nuclear reactors, Pressure vessels

Considerable advances have been made in the field of ultrasonic non-destructive testing over the past few years. In this paper some of these developments are reviewed in the context of the safe operation of a UK pressurized water reactor by ensuring the structural integrity of the reactor pressure vessel.

84-990

Products of Research and Development in NDT

P. Höller and V. Schmitz

Nucl. Engrg. Des., 76 (3), pp 233-249 (Dec 1983) 4 figs, 19 refs

Key Words: Nondestructive tests, Ultrasonic techniques, Failure detection

The Nondestructive Ultrasonic Testing and Evaluation is directed to describe flaws of the microstructure, structure residual stress, reliability and quality assurance. An overview is given on the scientific background, interpretation capability based upon mathematic-numerical models, new design of equipment and components containing relevant flaws. Examples are shown using the backscattering technique with linear polarized shear waves. Stress measurements are performed with electromagnetic ultrasonic probes. Surface inspection with magnetic imaging of the eddy current field or the multi-frequency eddy current methods are described.

84-991

Burst Random Excitation

N. Olsen

Hewlett-Packard Co., Marysville, WA, S/V, Sound Vib., 19 (11), pp 20-23 (Nov 1983) 15 figs, 1 table, 4 refs

Key Words: Dynamic tests, Testing techniques, Random excitation

Considerable time can be saved in the dynamic testing of large structures through the use of burst random excitation techniques. Leakage errors and other distortions of frequency response functions can be eliminated. This article reviews typical excitation functions and guidelines for implementing burst random excitation.

84-992

Laboratory Test Facility for Static and Dynamic Loading of Structures and Components

W.J. Carter

Terra Tek, Inc., Salt Lake City, UT, The Interaction of Non-Nuclear Munitions with Structures: Symp. Proc., U.S. Air Force Academy, CO, May 10-13, 1983, Part 2, pp 59-61 (AD-A132 116)
AD-P001 757

Key Words: Test facilities, Dynamic tests, Fatigue tests

A large-volume test frame designed for standard tension, compression or fatigue loading of massive samples has been modified to allow dynamic loading at rates up to 102/s. Scale model structures or structural materials in an arbitrary simulated environment may be tested in a variety of biaxial containment frames.

84-993

Computer-Based Ultrasonic Multiple-Frequency Pulse-Echo Test System

O.R. Gericke

Army Materials and Mechanics Res. Ctr., Watertown, MA, Rept. No. AMMRC-TR-83-43, 45 pp (July 1983)
AD-A132 227

Key Words: Ultrasonic techniques, Computer-aided techniques, Testing techniques

A computer-based ultrasonic pulse-echo test system that encompasses three separate ranges of test frequencies is described. Three super-imposed pulse-echo traces are produced, which are displayed in different colors. The system yields amplitude vs time as well as amplitude vs frequency information. Illustrative applications of the test system are discussed.

84-994

Seismic Behavior of an Eccentrically X-Braced Steel Structure

Ming-San Yang

Earthquake Engrg. Res. Ctr., Univ. of California, Berkeley, CA, Rept. No. UCB/EERC-82/14, NSF/CEE-82144, 263 pp (Sept 1982)
PB83-260778

Key Words: Earthquake resistant structures, Model testing, Seismic response

A five-story, one-third scale model structure of about 50 tons weight was tested on a shaking table at an earthquake engineering research center to study the earthquake resistant characteristics of an eccentrically X-braced structure. The eccentric bracing was created by a deliberate introduction of offsets into the brace-beam connections.

84-995

A Modal Survey Test Facility for Shuttle Payloads

N.W. Smith

Ball Aerospace Systems Div., Boulder, CO 80306, Intl. Modal Analysis Conf., Proc. 2nd, Orlando, FL, Feb 6-9, 1984, Spons. by Union College, Schenectady, NY, Vol. II, pp 661-666, 6 figs, 1 ref

Key Words: Space shuttles, Modal analysis, Experimental modal analysis, Test facilities

A cost effective modal survey facility which was designed for Shuttle Payloads is discussed. Use of existing vibration test equipment to reduce the initial cost of the facility is shown. A rigid shuttle bay simulating seismic fixture designed to hold shuttle payloads is described. A modal survey of the complete fixture, conducted to demonstrate its suitability, is discussed and the results are presented. The use of the facility on a shuttle launched spacecraft is included to demonstrate the success and shortcomings of the facility. A companion paper, "Modal Survey Testing/Mathematical Model Verification, a Cost Effective Approach for Shuttle Payloads" by A. Stroeve, further discusses the facility application.

DIAGNOSTICS

(Also see Nos. 786, 1009)

84-996

Diagnostic-Monitoring System for Power-Plant Boilers

M.D. Tucker and G.Y. Masada

Sandia Natl. Labs., Albuquerque, NM, Rept. No. SAND-83-1573C, CONF-830905-4, 8 pp (1983) (Pres. at the Joint Power Generation Conf., Indianapolis, IN, Sept 25, 1983)
DE83013997

Key Words: Diagnostic techniques, Monitoring techniques, Power plants (facilities), Boilers

A passive, microcomputer based diagnostic-monitoring system has been developed to continuously monitor thirty-two critical-boiler-state variables and to predict the root cause of abnormal behavior in the boiler processes and con-

trol system. The development of the diagnostic logic and algorithms are discussed and the system operation is illustrated by case studies.

84-997

Fracture Diagnosis in Structures Using Circuit Analogy

M. Akgun, F.J. Ju, and T.L. Paez

Univ. of New Mexico, Albuquerque, NM, The Interaction of Non-Nuclear Munitions with Structures: Symp. Proc., U.S. Air Force Academy, CO, May 10-13, 1983, Part 1, pp 146-150 (AD-A132 115)

AD-P001 732

Key Words: Diagnostic techniques, Crack detection, Circuit boards, Natural frequencies, Beams

Kirchloff's equations are used for the T- and II-circuits to analogously simulate beam vibration. Structures formed by straight beam segments can then be simulated by electrical meshes formed by T- or II-circuits. The analogous circuits are also developed for cracked beams. The natural frequencies of the circuits thus yield the natural frequencies of the structures with or without crack.

84-998

Physical Model of Nonlinear Noise with Application to BWR Stability

J. March-Leuba and R.B. Perez

Univ. of Tennessee, Knoxville, TN, Rept. No. CONF-830609-28, 10 pp (1983) (ANS Annual Mtg., Detroit, MI, June 12, 1983)

DE83014034

Key Words: Nuclear reactors, Diagnostic techniques

Within the framework of the present model it is shown that the BWR reactor cannot be unstable in the linear sense, but rather it executes limited power oscillations of a magnitude that depends on the operating conditions. The onset of these oscillations can be diagnosed by the decrease in stochasticity in the power traces and by the appearance of harmonics in the PSD.

84-999

Incipient Failure Detection for Fossil-Power-Plant Components: 1982 Conference and Workshop (Hartford, CT, Aug 25, 1982)

L.G. Rayes

Science Applications, Inc., Palo Alto, CA, Rept. No. EPRI-CS-2920, CONF-8208131, 657 pp (Mar 1983)

DE83901963

Key Words: Fossil power plants, Incipient failure detection, Proceedings

The seminar sessions were addressed to the following topics: current utility practices, vibration signature analysis, acoustic methods, developed and available monitoring systems, and new EPRI developments. In addition, there were five working groups: incipient failure detection in turbine-generators, incipient failure detection in boilers, vibration signature analysis techniques for incipient failure detection, acoustic emission techniques for incipient failure detection, and current utility methods for incipient failure detection.

84-1000

Pattern Recognition and Acoustic Emission

C.M. Scala and R.A. Coyle

Aeronautical Res. Labs., P.O. Box 4331, GPO Melbourne 3001, Australia, NDT Intl., 16 (6), pp 339-343 (Dec 1983) 2 figs, 1 table, 16 refs

Key Words: Acoustic emission, Pattern recognition techniques

Development of a pattern-recognition method to discriminate between emission from different acoustic emission (AE) sources is described. The method is based on extracting features of AE waveforms from an unknown source using computer analysis, and then comparing these features with those predicted for possible sources using theoretically and experimentally determined models of sources and calibration studies. The feasibility of using pattern-recognition studies to establish a basis for distinguishing between waveforms from a damage-related source and from several extraneous sources is demonstrated.

84-1001

Models for Damage Diagnosis in SDF Structures

Ming-Liang Wang, T.L. Paez, and F. Ju

Univ. of New Mexico, Albuquerque, NM, The Interaction of Non-Nuclear Munitions with Structures: Symp. Proc., U.S. Air Force Academy, CO, May 10-13, 1983, Part 1, pp 159-164 (AD-A132 115)

AD-P001-735

Key Words: Energy dissipation, Damage prediction, Failure analysis

In structural engineering it is imperative to design each system to survive the inputs anticipated over the design life of the structure. Strong motion inputs cause systems to execute nonlinear responses, and during strong motion responses structures accumulate damage. Two models for the simulation of damaged structural response have been developed. The objective of this study is to use these models to estimate the amount of energy dissipated due to a strong motion input. The results show that structural damage can be predicted, even in the presence of measurement noise.

MONITORING

(Also see Nos. 996, 1024)

84-1002

Monitoring of Blade Vibration through Detecting of Bearing Pedestal Vibration

S. Tanaka, M. Hayashida, S. Umemura, and K. Katayama

Mitsubishi Heavy Industries, Ltd., Japan, ASME *Paper No. 83-JPGC-Pwr-10*

Key Words: Monitoring techniques, Supports, Bearings, Vibration response, Blades

The characteristics of vibration signals of bearing pedestal affected by blade vibrations are investigated theoretically and experimentally. Classification factors of detectability for blade vibrations are obtained through the comparison between the measured data of blade vibrations and bearing pedestal vibrations and those data estimated by theoretical analysis. Detectable phenomena of rotating blade vibrations by this method are shown.

84-1003

Surveillance Systems (PWR) -- Loose Parts Monitoring -- Vibration Monitoring -- Leakage Detection

A. Schuette and H. Blaesig

Kernforschungszentrum Karlsruhe GmbH, Schule fuer Kerntechnik, Fed. Rep. Germany, Rept. No. INIS-mf-8009, CONF-821039-22, 33 pp (1982) (IAEA Intl. Symp. on Nuclear Power Plant Control and Instrumentation, Munich, Fed. Rep. Germany, Oct 11, 1982)

DE83780729

Key Words: Monitoring techniques, Nuclear reactors

A description of loose parts monitoring and vibration monitoring systems is described including location and type of sensors used, treatment of measurements and indications. The results of the analysis of some events picked up by the surveillance systems are presented showing applicability and benefit of such systems.

84-1004

Acoustic Emission Measurements on Large Scale Tensile Specimens Within the FKS-Program (Research Program Integrity of Components)

J. Eisenblätter and P. Runow

Battelle - Institut e.V., Frankfurt/Main, Fed. Rep. Germany, Nucl. Engrg. Des., 76 (3), pp 285-297 (Dec 1983) 12 figs, 1 table

Key Words: Monitoring techniques, Acoustic emission, Failure analysis, Crack detection

Within the FKS-Program (Research Program Integrity of Components) acoustic emission measurements were carried out on large flat and cylindrical specimens manufactured from partly modified reactor steel with the following purpose: to distinguish the different origins of acoustic emission, to recognize the onset of subcritical crack growth, and to predict fracture.

84-1005

Acoustic Emission Measurements During Welding of a 250 mm TESTPLATE

G. Deuster and R. Sinz

Fraunhofer - Institut f. zerstörungsfreie Prufverfahren, Saarbrücken, Fed. Rep. Germany, Nucl. Engrg. Des., 76 (3), pp 299-308 (Dec 1983) 13 figs, 9 refs

Key Words: Monitoring techniques, Acoustic emission, Failure analysis, Welding

The capability of the acoustic emission monitoring system is demonstrated for a multi-layer submerged arc weld of a 250 mm test plate.

84-1006

Torsional Monitoring of Large Steam Turbine-Generators

J.C. White, D.N. Walker, and A.J. Perez

EPRI, Palo Alto, CA, ASME Paper No. 83-JPGC-Pwr-2

Key Words: Monitoring techniques, Torsional vibration, Fatigue life, Steam turbines

Two interrelated research projects have been initiated. One is aimed at developing a procedure for estimating torsional fatigue life expenditure based on an extensive test program. The other is a monitoring project directly aimed at providing industry working groups with the necessary electrical and mechanical statistics so that they can draw meaningful conclusions and make operational recommendations.

84-1007

On-Line Monitoring of Turbine-Generator Shaft Cracking

A.F. Armor

EPRI, Palo Alto, CA, ASME Paper No. 83-JPGC-Pwr-7

Key Words: Monitoring techniques, Computer-aided techniques, Shafts, Failure detection, Crack detection

This paper discusses progress on three on-line techniques to detect the formation of cracks in shafts: vibration signature analysis, acoustic emission monitoring, and eddy current monitoring.

84-1008

Supervision of the Vibration of Rotating Components

Statens Vattenfallsverk, Vaellingby, Sweden, Rept. No. SV-FUD-1-9, 437 pp (June 1982)

DE83701137

(In Swedish)

Key Words: Monitoring techniques, Rotors, Nuclear power plants

The aim of the investigation was to appeal for the systematization and uniformity of surveillance and to form a source of information to the makers of instruments, suppliers of engines, consultants and others. Two essential topics are treated; namely, rotor dynamics and measuring methods for vibration control. An inventory of damages and problems of rotating machinery is presented.

84-1009

Operating Experience with Health Monitoring and Diagnosis of M.D. Steam Turbines and Centrifugal Compressors

M.P. Boyce, C. Meher-Homji, G. Mani, T. Lam, and R. Ansell

Boyce Engineering International, Inc., Houston, TX, ASME Paper No. 83-JPGC-Pwr-28

Key Words: Monitoring techniques, Diagnostic techniques, Steam turbines, Centrifugal compressors

The philosophy behind machinery health monitoring and diagnostic systems is described. Design aspects as well as some operating experiences are described.

84-1010

A Noncontacting Laser Doppler Sensor for Monitoring Turbine Generator Vibrations

S.R. Mannava, W.R. Mielke, Jr., and A.F. Armor

General Electric Co., Palo Alto, CA, ASME Paper No. 83-JPGC-Pwr-26

Key Words: Monitoring techniques, Proximity probes, Lasers, Turbogenerators

Test results obtained from a rotating target in the laboratory and a full-size turbine generator rotor in the factory are presented. Plans for development of a portable vibration instrument and for its use in a power plant environment are described.

84-1011

Remote Monitoring of Steam Turbine Parameters of the New Self-Aligning Thrust Bearing

O. Tuncel, D.B. Carter, and B. Sert

General Electric Co., Lynn, MA, ASME Paper No. 83-JPGC-Pwr-13

Key Words: Monitoring techniques, Bearings, Steam turbines

This paper presents the test program involving remote monitoring of steam turbine parameters of the new self-aligning thrust bearing, in two single automatic-extraction, noncondensing turbines.

84-1012

Monitoring System of Steam Turbine Governor

Y. Otawara, K. Ichiryu, and N. Iwata

Hitachi, Ltd., Japan, ASME Paper No. 83-JPGC-Pwr-12

Key Words: Monitoring techniques, Steam turbines, Turbine components

Three component systems developed to monitor and detect malfunctions of a steam turbine governor are described.

84-1013

Automatic Monitoring of Rotating Tools in Metal-Cutting Manufacture Using Distance and Vibration Sensors (Automatische Uberwachung Rotierender Werkzeuge mit Abstands- und Schwingungssensoren in der spanabhebenden Fertigung)

F. Quante, H. Fehrenbach, and H.-E. Meier

Fraunhofer-Institut f. Informations- und Datenverarbeitung (IITB), Sebastian-Kneipp-Strasse 12-14, D-7500 Karlsruhe 1, Germany, Techn. Messen-TM, 50 (10), pp 367-371 (1983) 4 figs, 3 tables, 12 refs (In German)

Key Words: Monitoring techniques, Computer-aided techniques, Machine tools, Drills

Monitoring systems for tools are necessary in automatic mechanical production, since tool failure may cause considerable damage. The monitoring tasks for some rotating tools are described, existing supervision methods are compared, and future use of distance and vibration measurements are proposed, the suitability of which is shown experimentally for drills.

ANALYSIS AND DESIGN

ANALYTICAL METHODS

84-1014

Deliberations on the Improvement of the Computational Model with Measured Eigenvalues

H.G. Natke

Curt-Risch-Institute of Vibration and Measurement Tech., Univ. of Hanover, Fed. Rep. Germany, Rev. Roumaine Sci. Tech., Mecanique Appl., 28 (2), pp 159-173 (Mar/Apr 1983) 1 fig, 4 tables, 12 refs

Key Words: Natural frequencies, Least squares method, Modal analysis

Usually, the eigenvalues of an associated undamped system and a damping ratio of each degree of freedom of the system under test are measured. In general these results are erroneous and incomplete. Three adjustment methods based on different measured data sets using the weighted least squares method as the estimation procedure are discussed.

84-1015

Dynamic Buckling of an Ice Strip by Axial Impact

L.H.N. Lee and K.L. Ettestad

Dept. of Aerospace and Mech. Engrg., Univ. of Notre Dame, Notre Dame, IN 46556, Intl. J. Impact Engrg., 1 (4), pp 343-356 (1983) 7 figs, 8 refs

Key Words: Dynamic buckling, Ice, Axial force, Bifurcation theory

The dynamic buckling of an ice strip in a two-phase de-icing process is simulated by that of an idealized elastic strip of a finite length, supported by an elastic-rigid foundation and subjected to an axial impact. The dynamic buckling process in the principal eigenmode of motion of the elastic strip is analytically determined by a quasi-bifurcation theory. A numerical approach is developed for obtaining solutions which satisfy the elastic-rigid constraints. Numerical results are obtained and presented.

84-1016

On the Importance of the Discrete Maximum Principle in Transient Analysis Using Finite Element Methods

E. Rank, C. Katz, and H. Werner

Fachgebiet Elektronisches Rechnen im Konstruktiven Ingenieurbau, Technische Universität, München, W. Germany. Intl. J. Numer. Methods Engrg., 19 (12), pp 1771-1782 (Dec 1983) 4 figs, 10 refs

Key Words: Transient analysis, Finite element technique

In transient analysis it is generally thought that small time steps can only improve the accuracy, because standard

stability theorems limit the maximum time step for a given mesh size. In finite element approximations, however, small time steps may cause stability problems which lead to physically unreasonable results. It is shown that this is due to the violation of a discete maximum principle. The influence of lumped and consistent mass matrices on a stable discretization of time and space is presented.

MODELING TECHNIQUES

(Also see No. 908)

84-1017

Discrete Model Improvement by Eigenvector Updating

M. Zak

Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, ASCE J. Engrg. Mech., 109 (6), pp 1437-1444 (Dec 1983) 5 refs

Key Words: Modal tests, Mathematical models

An eigenvector updating method is proposed to fit modal test data. The calculated eigenvectors are updated by coinciding some of them with the corresponding measured eigenvectors as a result of an orthogonal transformation. The advantage of the method is the applicability to large complex structures without necessity of recomputation of the eigendata.

STATISTICAL METHODS

84-1018

First-Passage Probability for Two-Mode Systems

L.D. Lutes and Shen-Ho Tzuang

Robert L. Cloud Associates, Inc., Berkeley, CA, ASCE J. Engrg. Mech., 109 (6), pp 1358-1374 (Dec 1983) 7 figs, 13 refs

Key Words: Probability theory

First-passage probabilities are investigated for the absolute value of the zero-start response of 2DF linear oscillators excited by stationary white noise having a normal probability distribution. Only the long-time portion of the response has been studied. Most attention is given to the exponential decay rate of the probability of survival, but some data is also given for the generally less important multiplier of the exponential term.

PARAMETER IDENTIFICATION

84-1019

Identification of the Dynamic Characteristics of a Simple System with Quadratic Damping

M. Rades

Polytechnic Inst., Bucharest, Romania, Rev. Roumaine Sci. Tech., Mecanique Appl., 28 (4), pp 439-446 (July/Aug 1983) 4 figs, 9 refs

Key Words: Parameter identification technique, Quadratic damping, Single degree of freedom systems

Two methods are presented for the estimation of the dynamic parameters of a single degree of freedom system with directly coupled quadratic damping. The required experimental data are a set of polar diagrams of the harmonic response plotted for different (constant magnitude) force excitation levels.

84-1020

Modal Identification of a Rotating-Blade System

T.G. Carne, D.R. Martinez, and S.R. Ibrahim

Sandia Natl. Labs., Albuquerque, NM, Rept. No. SAND-82-2115, 20 pp (Apr 1983)

DE83015631

Key Words: Parameter identification techniques, Modal analysis, Rotor blades (turbomachinery)

A new testing technique and the Ibrahim time-domain (ITD) modal identification algorithm have been combined, resulting in a capability to estimate modal parameters for rotating-blade systems. This capability has been evaluated on a two-meter, vertical-axis wind turbine.

DESIGN TECHNIQUES

84-1021

Animating Forced Response of Structures

B. Colyer

Rutherford Appleton Lab., Science and Engrg. Res. Council, Chilton, UK, Rept. No. RL-83-068, 15 pp (1983)

PB84-109255

Key Words: Graphic techniques, Computer-aided techniques, Design techniques, Structural design, Vibration response

A Perq single user computer can be used to animate the forced response of a structure, thus assisting in designing structures which are subjected to vibration environments. The design of the program is described.

COMPUTER PROGRAMS

84-1022

BLOWDOWN Force Analysis of Piping System under LOCA Conditions Using BLOWDOWN Code

N. Miyazaki and T. Akimoto
Kyushu Univ., Higashi-ku, Fukuoka-shi, Fukuoka-ken, Japan, Nucl. Engrg. Des., 76 (2), pp 121-135 (Nov 1983) 13 figs, 1 table, 8 refs

Key Words: Computer programs, Pipelines, Nuclear power plants, Pipe whip

The BLOWDOWN code was developed for blowdown force analysis of piping system under LOCA conditions. This is a post-processor of the thermal-hydraulic analysis code RELAP4/MOD6. The results obtained from the RELAP4/MOD6 code are converted into blowdown forces by the BLOWDOWN code. The physics and algorithms of the BLOWDOWN code are outlined. Numerical examples are also presented.

84-1023

Analysis of Dynamic Behavior of a PWR Utilizing the Computer Program SARDAN 2

J.A.O. Pessanha
Pontificia Univ. Catolica do rio de Janeiro, Brazil, Rept. No. INIS-mf-7856, 276 pp (July 1982)
DE83781009
(In Portuguese)

Key Words: Computer programs, Nuclear power plants, Transient response

In the design of a PWR nuclear plant it is necessary to verify if the design limits are respected, even under abnormal operation condition. An evolution of SARDAN code, developed to simulate transients in PWR, are presented. The new aspects incorporated in SARDAN 2 are: the fuel ROD analysis in finite-difference, an open channel model for the critic subchannel analysis and the introduction of a simplified model for the automatic control system.

84-1024

Monitoring and Real-Time Operation Software for Modcomp Classic (Logiciel de Surveillance et de Traitement en Temps Reel sur Modcomp Classic)

J.L. Duchateau
Div. Machines Tournantes, Electricite de France, Clamart, France, Rept. No. HM-16-977, 11 pp (Mar 19, 1982)
N83-34647
(In French)

Key Words: Computer programs, Monitoring techniques, Rotors

Software for processing model rotor data on the Modcomp minicomputer is described. A tracing table can be followed on VDU's, and the evolution of 128 sizes can be followed by oscilloscope. It handles 32 alarms, sending error messages.

84-1025

Maximum Likelihood Program for Nonlinear System Identification with Application to Aircraft Flight Data Compatibility Checking

R.A. Feik
Aeronautical Res Labs., Melbourne, Australia, Rept. No. ARL/AERO NOTE-411, 43 pp (July 1982)
AD-A133 157

Key Words: Computer programs, System identification techniques, Maximum likelihood method, Aircraft

A Fortran program has been developed for the maximum likelihood estimation of parameters in nonlinear systems. The program structure uses subroutines to describe the problem and define problem-specific elements, while the main program is designed to be problem-independent as far as possible. In the present note an application of the program to compatibility checking of aircraft dynamic flight test data has been studied.

84-1026

Implementation of Transient and Frequency Response Algorithms Using the UWIST (University of Wales Inst. of Science and Technology) VAX/VMS Computer

K. Waggitt
Dept. of Mech. Engrg. and Engrg. Production, Univ. of Wales Inst. of Science and Tech., Cardiff, Wales,

Rept. No. UWIST-DMEEP/DAG-142, 27 pp (1982)
PB84-103554

Key Words: Computer programs, Transient response, Frequency response

This paper describes the development and use of threee programs developed by the UWIST Dynamic Analysis Group. The first is used to calculate the transient response of a given transfer function for standard inputs such as unit impulse and steps. The program uses the Liou method to evaluate the response. The second program is used to evaluate frequency response and the third to evaluate roots of a polynomial. All programs were written in FORTRAN for implementation on the VAX/VMS computer.

84-1027

Soil Model Evaluation under Dynamic Loadings

W.C. Dass and J.L. Bratton

Applied Res. Associates, Inc., Albuquerque, NM, The Interaction of Non-Nuclear Munitions with Structures: *Symp. Proc.*, U.S. Air Force Academy, CO, May 10-13, 1983, Part 2, pp 76-81 (AD-A132 116)
AD-P001 760

Key Words: Computer programs, Constitutive equations, Soils, Sand, Explosion effects, Impulse response

Many different types of constitutive relationships are available for calculating the response of geologic media to impulsive loading. This paper describes a computer code which has been developed as an aid for studying material constitutive models. The soil element model (SEM) can calculate the response of a given material model to laboratory and in-situ test conditions, arbitrary strain paths, or one-dimensional wave propagation. It is useful for developing models, performing parametric studies to determine model component influence, and comparing model behaviors. A study is presented which illustrates the use of this code to compare the ability of several material models to replicate laboratory and in-situ data.

84-1028

Examples in the Use of the Finite Element Library: Forced Vibration of an Elastic Solid. Direct Integration by Newmark's Method

C. Greenough and K. Robinson

Rutherford Appleton Lab., Science and Engrg. Res. Council, Chilton, UK, Rept. No. RL-82-064, 24 pp (1982)
PB83-256263

Key Words: Computer programs, Forced vibration, Newmark method

The program was used to calculate the displacements, velocities and accelerations of a two-dimensional rectangular solid acted upon by a time dependent force. The report presents the theory of the equations of motion; the numerical integration method; the program structure; a listing of the code; and results obtained by running the program for a given set of example conditions.

84-1029

User's Manual for CABLE – A Three-Dimensional, Finite-Segment Computer Code for Submerged and Partially Submerged Cable Systems

J.W. Kamman and R.L. Huston

Dept. of Mech. and Indus. Engrg., Univ. of Cincinnati, Cincinnati, OH, Rept. No. UC-MIE-050183-15-ONR, 41 pp (May 1, 1983)
AD-A132 515

Key Words: Computer programs, Cables, Underwater structures

This manual provides instruction for using CABLE to study such cable systems. It also provides sample input and output data. The computer program itself is written in FORTRAN. Hence, the input requirements are in the FORTRAN format. CABLE is designed to perform the following dynamic analyses: Given: a) the physical data of the cable (weight, diameter, length) and the physical data of the towed body; b) the configuration of the cable branches; c) the fluid properties; d) the motion of the towed end of the cable; and e) the initial configuration of the cable system; then the program determines the kinematics (position, velocity, and acceleration) at the various points of the cable system as well as the cable tension.

84-1030

Extreme Dynamic Loading Effects on Steel and Concrete Shell Structures

Y. Crutzen

Control Data Italia, Milan, Italy, The Interaction of Non-Nuclear Munitions with Structures: Symp. Proc., U.S. Air Force Academy, CO, May 10-13, 1983, Part 1, pp 141-145 (AD-A132 115)
AD-P001 731

Key Words: Computer programs, Shock waves, Wave propagation, Shells

Using the modern computerized analysis, the special purpose computer program SLOOFSAN can be successfully applied for the evaluation of thin structure strength limits in the presence of extreme dynamic loading phenomena. This program correctly solves wave-propagation-type problems involving short transient (very rapid loading-time sequence) and including shock-wave response from impulsive loading (explosion or blast wave) and impact loading (missile impact). SLOOFSAN program is based on a finite element shell formulation using the Semiloof element and has been developed for transient dynamic nonlinear analysis applying an efficient explicit direct time integration technique.

GENERAL TOPICS

CONFERENCE PROCEEDINGS

84-1031
Wind and Seismic Effects. Proceedings of the Joint Panel Conference of the U.S. - Japan Cooperative Program in Natural Resources (11th)

H.S. Lew

Natl. Engrg. Lab., Natl. Bureau of Standards, Washington, DC, Rept. No. NBS-SP-658, 755 pp (July 1983)

PB83-252791

Key Words: Wind-induced excitation, Seismic response, Proceedings

Subjects covered include the engineering characteristics of wind, characteristics of earthquake ground motions, earthquake response of structures, wind response of structures, recent design criteria against wind and earthquake disturbances, design and analysis of special structures, evaluation, repairing, and retrofitting for wind and earthquake disaster, earthquake disaster prevention planning, storm surge and tsunamis, and technical cooperation with developing countries.

84-1032
Computer-Aided Noise Measurement Technology (Rechnerunterstutzte Gerauschmesstechnik)

Conf. Proc., Dusseldorf, Germany, Feb. 1983, VDI Berichte Nr. 468, 122 pp

(In German)

Key Words: Noise measurement, Computer-aided techniques, Proceedings

The aim of this conference was to acquaint the specialist and the practicing engineer with the recent noise measurement technology made possible by computers, and with the results and limitations of such systems in the solution of acoustics problems arising in measurement of emission, immission and architectural acoustics. The volume contains 23 papers and discussions.

TUTORIALS AND REVIEWS

(See no. 907)

BIBLIOGRAPHIES

(See Nos. 795, 984)

AUTHOR INDEX

TECHNICAL NOTES

K.P. Soldatos
Equivalence of Some Methods Used for the Dynamic Analysis of Cross-Ply Laminated Oval Cylindrical Shells
J. Sound Vib., 91 (3), pp 461-465 (Dec 8, 1983) 6 refs

A. Mioduchowski and W. Nadolski
Torsional Deformations of a Shaft with Rotor Having Time-Dependent Moment of Inertia
Meccanica, 18 (3), pp 182-184 (Sept 1983) 3 figs, 2 refs

C.V.R. Reddy, R. Bhat, and B.V.A. Rao
A Note on the Reduction of Radiated Noise from a Cement Mill by the Application of Damping Treatment
J. Sound Vib., 91 (4), pp 601-603 (Dec 22, 1983) 2 figs, 1 ref

N. Kyouno, Y. Takeya, Y. Yamabuchi, and Y. Kagawa
Loudspeaker Characteristic Calculation by the Finite Element Method -- Comparison with Measured Results
J. Sound Vib., 91 (4), pp 604-607 (Dec 22, 1983) 5 figs, 1 ref

S.K. Jain
Seismic Response of Buildings with Flexible Floors
ASCE J. Engrg. Mech., 110 (1), pp 125-129 (Jan 1984) 2 figs, 3 refs

T. Irie, G. Yamada, and K. Tanaka
Natural Frequencies of Truncated Conical Shells
J. Sound Vib., 92 (3), pp 447-453 (Feb 8, 1984) 1 fig, 4 tables, 1 ref

B.H.K. Lee
A Method for Predicting Wing Response to Buffet Loads
J. Aircraft, 21 (1), pp 85-87 (Jan 1984) 2 figs, 7 refs

J. Kujawski and C.S. Desai
An Exact Numerical Time Integration of Scalar Equations for Undamped Structural Systems
Earthquake Engrg. Struc. Dynam., 12 (1), pp 137-142 (Jan/Feb 1984) 2 figs, 2 tables, 6 refs

CALENDAR

JUNE 1984

4-7 29th International Gas Turbine Conference and Exhibit [ASME] Amsterdam, The Netherlands *(ASME Hqs.)*

17-21 Applied Mechanics, Bioengineering, and Fluids Engineering Conference [ASME] San Antonio, TX *(ASME Hqs.)*

26-28 Machinery Vibration Monitoring and Analysis Meeting [Vibration Institute] New Orleans, LA *(Dr. Ronald L. Eshleman, Director, The Vibration Institute, 101 W. 55th St., Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254)*

JULY 1984

21-28 8th World Conference on Earthquake Engineering [Earthquake Engineering Research Institute] San Francisco, CA *(EERI-8WCEE, 2620 Telegraph Avenue, Berkeley, CA 94704)*

AUGUST 1984

5-9 3rd International Conference on Solid Lubrication [ASLE] Denver, CO *(ASLE Hqs.)*

6-9 West Coast International Meeting [SAE] San Diego, CA *(SAE Hqs.)*

12-16 International Computers in Engineering Conference and Exhibit [ASME] Las Vegas, NV *(ASME Hqs.)*

19-25 XVIth International Congress on Theoretical and Applied Mechanics [International Union of Theoretical and Applied Mechanics] Lyngby, Denmark *(Prof. Frithiof Niordson, President, or Dr. Niels Olhoff, Executive Secretary, ICTAM, Technical University of Denmark, Bldg. 404, Dk-2800 Lyngby, Denmark)*

SEPTEMBER 1984

9-11 Petroleum Workshop and Conference [ASME] San Antonio, TX *(ASME Hqs.)*

11-13 Third International Conference on Vibrations in Rotating Machinery [Institution of Mechanical Engineers] University of York, UK *(IMechE Hqs.)*

30-Oct 4 Power Generation Conference [ASME] Toronto, Ontario, Canada *(ASME Hqs.)*

OCTOBER 1984

7-11 10th Design Automation Conference and 18th Mechanisms Conference [ASME] Cambridge, MA *(Prof. Panos Papalambros, Mechanical Engineering and Applied Mechanics, The University of Michigan, Ann Arbor, MI 48109 - (313) 763-1046)*

8-12 Acoustical Society of America, Fall Meeting [ASA] Minneapolis, MN *(ASA Hqs.)*

9-11 13th Space Simulation Conference [IES, AIAA, ASTM, and NASA] Orlando, FL *(Institute of Environmental Sciences, 940 E. Northwest Hwy., Mt. Prospect, IL 60056 - (312) 255-1561)*

15-18 Aerospace Congress and Exposition [SAE] Long Beach, CA *(SAE Hqs.)*

17-19 Stapp Car Crash Conference [SAE] Chicago, IL *(SAE Hqs.)*

22-24 ASME/ASLE Lubrication Conference [ASME/ASLE] San Diego, CA *(ASLE Hqs.)*

22-25 Symposium on Advances and Trends in Structures and Dynamics [George Washington University and NASA Langley Research Center] Washington, DC *(Prof. Ahmed K. Noor, Mail Stop 246, GWU-NASA Langley Research Center, Hampton, VA 23665 - (804) 865-2897)*

DECEMBER 1984

3-5 International Conference on Noise Control Engineering [International Institute of Noise Control Engineering] Honolulu, Hawaii *(William W. Lang, Chairman, INTER-NOISE 84, P.O. Box 3469 Arlington Branch, Poughkeepsie, NY 12603)*

3-6 Truck and Bus Meeting and Exposition [SAE] Dearborn, MI *(SAE Hqs.)*

9-13 ASME Winter Annual Meeting [ASME] New Orleans, LA *(ASME Hqs.)*

CALENDAR ACRONYM DEFINITIONS AND ADDRESSES OF SOCIETY HEADQUARTERS

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ASCE:	American Society of Civil Engineers United Engineering Center 345 E. 47th St. New York, NY 10017
ASLE:	American Society of Lubrication Engineers 838 Busse Highway Park Ridge, IL 60068
ASME:	American Society of Mechanical Engineers United Engineering Center 345 E. 47th St. New York, NY 10017
ASTM:	American Society for Testing and Materials 1916 Race St. Philadelphia, PA 19103
ICF:	International Congress on Fracture Tohoku University Sendai, Japan
IEEE:	Institute of Electrical and Electronics Engineers United Engineering Center 345 E. 47th St. New York, NY 10017
IES:	Institute of Environmental Sciences 940 E. Northwest Highway Mt. Prospect, IL 60056
IMechE:	Institution of Mechanical Engineers 1 Birdcage Walk, Westminster, London SW1, UK
IFToMM:	International Federation for Theory of Machines and Mechanisms U.S. Council for TMM c/o Univ. Mass., Dept. ME Amherst, MA 01002
INCE:	Institute of Noise Control Engineering P.O. Box 3206, Arlington Branch Poughkeepsie, NY 12603
ISA:	Instrument Society of America 67 Alexander Dr. Research Triangle Park, NC 27709
SAE:	Society of Automotive Engineers 400 Commonwealth Dr. Warrendale, PA 15096
SEE:	Society of Environmental Engineers Owles Hall, Buntingford, Hertz. SG9 9PL, England
SESA:	Society for Experimental Stress Analysis 14 Fairfield Dr. Brookfield Center, CT 06805
SNAME:	Society of Naval Architects and Marine Engineers 74 Trinity Pl. New York, NY 10006
SPE:	Society of Petroleum Engineers 6200 N. Central Expressway Dallas, TX 75206
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SUMMARY COVER SHEET
55th SHOCK AND VIBRATION SYMPOSIUM
DAYTON, OH, 23-25 OCTOBER 1984
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The Shock and Vibration Bulletin is a refereed journal which contains the proceedings of the symposium and an additional number of papers not presented at the symposium.

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SUMMARY OF SHORT DISCUSSION TOPIC
55th SHOCK AND VIBRATION SYMPOSIUM
DAYTON, OH, 23-25 OCTOBER 1984

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PUBLICATION POLICY

Unsolicited articles are accepted for publication in the **Shock and Vibration Digest.** Feature articles should be tutorials and/or reviews of areas of interest to shock and vibration engineers. Literature review articles should provide a subjective critique/summary of papers, patents, proceedings, and reports of a pertinent topic in the shock and vibration field. A literature review should stress important recent technology. Only pertinent literature should be cited. Illustrations are encouraged. Detailed mathematical derivations are discouraged; rather, simple formulas representing results should be used. When complex formulas cannot be avoided, a functional form should be used so that readers will understand the interaction between parameters and variables.

Manuscripts must be typed (double-spaced) and figures attached. It is strongly recommended that line figures be rendered in ink or heavy pencil and neatly labeled. Photographs must be unscreened glossy black and white prints. The format for references shown in DIGEST articles is to be followed.

Manuscripts must begin with a brief abstract, or summary. Only material referred to in the text should be included in the list of References at the end of the article. References should be cited in text by consecutive numbers in brackets, as in the example below.

> Unfortunately, such information is often unreliable, particularly statistical data pertinent to a reliability assessment, as has been previously noted [1].
>
> Critical and certain related excitations were first applied to the problem of assessing system reliability almost a decade ago [2]. Since then, the variations that have been developed and the practical applications that have been explored [3-7] indicate that . . .

The format and style for the list of References at the end of the article are as follows:

- each citation number as it appears in text (not in alphabetical order)
- last name of author/editor followed by initials or first name
- titles of articles within quotations, titles of books underlined
- abbreviated title of journal in which article was published (see Periodicals Scanned list in January, June, and December issues)
- volume, number or issue, and pages for journals; publisher for books
- year of publication in parentheses

A sample reference list is given below.

1. Platzer, M.F., "Transonic Blade Flutter - A Survey," Shock Vib. Dig., 7 (7), pp 97-106 (July 1975).
2. Bisplinghoff, R.L., Ashley, H., and Halfman, R.L., Aeroelasticity, Addison-Wesley (1955).
3. Jones, W.P., (Ed.), "Manual on Aeroelasticity," Part II, Aerodynamic Aspects, Advisory Group Aeronaut. Res. Dev. (1962).
4. Lin, C.C., Reissner, E., and Tsien, H., "On Two-Dimensional Nonsteady Motion of a Slender Body in a Compressible Fluid," J. Math. Phys., 27 (3), pp 220-231 (1948).
5. Landahl, M., Unsteady Transonic Flow, Pergamon Press (1961).
6. Miles, J.W., "The Compressible Flow Past an Oscillating Airfoil in a Wind Tunnel," J. Aeronaut. Sci., 23 (7), pp 671-678 (1956).
7. Lane, F., "Supersonic Flow Past an Oscillating Cascade with Supersonic Leading Edge Locus," J. Aeronaut. Sci., 24 (1), pp 65-66 (1957).

Articles for the DIGEST will be reviewed for technical content and edited for style and format. Before an article is submitted, the topic area should be cleared with the editors of the DIGEST. Literature review topics are assigned on a first come basis. Topics should be narrow and well-defined. Articles should be 3000 to 4000 words in length. For additional information on topics and editorial policies, please contact:

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